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THE ONTARIO ASSESSMENT INSTRUMENT POOL

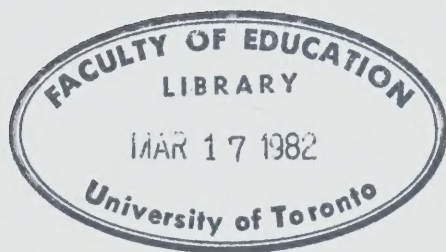
# CHEMISTRY II

SENIOR DIVISION



Ministry  
of  
Education

Hon. Bette Stephenson, M.D., Minister  
Harry K. Fisher, Deputy Minister



The Ontario Assessment Instrument Pool (Chemistry) consists  
of packages of assessment materials related to the  
S- ONTARIO ASSESSMENT INSTRUMENT POOL Division Chemistry

Curricula. Additional materials will be published as they

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Queen's Park  
Toronto, Ontario

ISBN 0-7743-6789-x

ISSN 0228-0957

ON 02179

This is package number two (of four packages) of  
assessment materials related to the Ministry of Education  
curriculum guideline for Chemistry, Senior Division. It  
consists of: a list of objectives for S-17 D, multiple-  
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Multiple Choice Instruments

S-17D (Grade 12) (456 pages)

a) List of Objectives

b) Multiple Choice Instruments

c) Statistical Tables

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The Ontario Assessment Instrument Pool (Chemistry) consists of four (4) packages of assessment materials related to the S-17D (1966) and S-17E (1967) Senior Division Chemistry Curricula. Additional materials will be published as they become available.

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## CHAPTER 12

### MULTIPLE CHOICE INSTRUMENTS

#### (a) S17D OBJECTIVES

##### UNIT 1 INTRODUCTION

Upon completion of this topic, the student should be able to:

- 12A.1      define science  
             define pure science  
             define applied science  
             differentiate between pure and applied science  
             define chemistry  
             differentiate between chemistry and other sciences
- describe the relationships between chemistry and  
             other sciences
- adopt a positive attitude towards career  
             opportunities related to the study of chemistry
- appreciate chemistry as an essential part of daily life
- identify examples of chemistry in the media
- list examples of chemistry in the home environment
- define scientific method
- list the steps in the scientific method
- define hypothesis
- define experiment
- define observation
- define theory
- define law
- define model
- differentiate between observations and conclusions
- apply the scientific method given a problem within  
             chemistry
- appreciate the effectiveness of the scientific method

differentiate between scientific and non-scientific methods given examples

identify the steps in the scientific method given a description of a procedure

make whatever generalizations are possible from a list of valid observations

name and define quantities that can be measured directly

list imperfections that make science a human pursuit

explain why methods other than the traditional scientific method are appropriate for the investigation of nature and matter

develop the relations between experimental data and theory in a systematic fashion

identify as a law, theory or model a description of a physical phenomenon

make as many valid observations as possible in any given laboratory exercise

determine which variables are controlled given an experimental procedure

list patterns which exist in a table of data

state the validity of the conclusion, given a table of data and conclusions

distinguish between qualitative and quantitative observations given a list of examples

relate the scientific method to everyday human activities

differentiate between counting and measuring

state what is meant by the term "accepted value"

develop an interest in current scientific matters in literature and in the "media"

12A.1.2 define matter

define pure substance

define mechanical mixture

differentiate between a pure substances and a mechanical mixtures

state the characteristics of a pure substance

design and/or perform an experiment to determine whether a sample is a pure substance or a mechanical mixture

design and/or perform an experiment to separate the components of a mechanical mixture

state various methods for classifying substances

list examples of pure substances

list examples of mechanical mixtures

12A.1.3 define physical property

define chemical property

identify substances, in terms of properties

list some characteristic physical properties of matter

list some characteristic chemical properties of matter

describe how properties may be used to distinguish a pure substance from an impure one

design and/or perform an experiment to determine the characteristic properties of a pure substance

12A.1.4 define element

define compound

state the Law of Constant Composition (Definite Proportions)

illustrate by experiment the Law of Constant Composition (Definite Proportions)

12A.1.5 distinguish between synthesis (combination) and decomposition (analysis)

distinguish between a chemical and a physical property

give examples of decomposition

give examples of synthesis

distinguish between a physical and a chemical change

distinguish experimentally between physical and chemical changes

design and/or perform an experiment to illustrate the decomposition of a compound

design and/or perform an experiment to illustrate the synthesis of a compound

## THE STRUCTURE OF INDIVIDUAL ATOMS

### UNIT II

Upon completion of this topic, the student should be able to:

- 12A.2.1        list the fundamental particles of the atom (electron, proton, neutron)
  - recall that the SI symbol for atomic mass unit is u
- 12A.2.1.a     compare the absolute masses of the fundamental particles to the proton taken as 1.00 u
  - compare the relative charges of the fundamental particles to the proton taken as +1
  - recall the approximate sizes of the fundamental particles
  - design and/or perform an experiment to determine the approximate size of an atom
- 12A.2.2        define atom
- 12A.2.2.a     recall the locations of the fundamental particles within the nuclear atom
  - outline Rutherford's gold foil experiment leading to the nuclear atom
  - compare the relative diameter and volume of the nucleus to the entire atom
- 12A.2.2.b     define atomic number
  - recall that the abbreviation for atomic number is Z
  - define atomic mass
  - recall that the abbreviation for atomic mass is A
- 12A.2.2.c     write the electronic arrangement for elements one to twenty
- 12A.2.2.d     draw a schematic diagram for elements one to twenty
- 12A.2.2.e     define: atomic number, mass number, isotope, atomic mass unit, relative atomic mass
  - list common isotopes of such atoms as hydrogen and chlorine
  - outline some industrial uses of isotopes

- recall that the ratio of abundance of a natural isotope to another natural isotope is nearly constant for each element on earth
  - calculate the number of each fundamental particle in a given isotope
  - recall the formula for heavy water
  - recall the use of heavy water as a moderator in the CANDU nuclear reactor
  - differentiate between  $u$  and  $Z$
  - calculate the percentage by mass of an isotope of a certain element in a given sample
  - differentiate between atomic mass and mass number
  - calculate the atomic mass of an element from experimental data
  - calculate the relative abundance of isotopes of an element from experimental data
  - state the relationship between mass number and atomic mass
  - list information imparted by a chemical symbol
  - identify any element from one to twenty using a periodic table
  - calculate the mass of an atom of an element from carbon 12 data
- 12A.2.3.a
- define: ion, noble gas
  - explain the lack of reactivity of the noble gases
  - list several compounds of the noble gases
  - explain the tendency of other elements to lose or gain electrons
  - state the octet rule
  - predict stable electronic arrangements for the first twenty elements given their electron distributions
  - explain the stability of the  $\text{Na}^+$  and  $\text{Cl}^-$  ions

predict the most likely ion for elements one to twenty

explain why elements of groups 1, 2, 6, and 7 are generally reactive

12A.2.3.b      define electron affinity

sketch the Lewis dot diagrams for simple ions

calculate the charge of an ion from electron and proton data

explain how an ion forms from an atom

12A.2.3.c      define electropositivity

explain why elements are electronegative or electropositive

define electronegative ions, and electropositive ions

identify elements as metals or non metals

## THE STRUCTURE OF AGGREGATES OF ATOMS

### UNIT III

Upon completion of this topic, the student should be able to:

- 12A.3.1      recall that isolated atoms do not normally occur in nature
- recall that noble gases normally occur as isolated atoms
- differentiate between monatomic and diatomic gases
- 12A.3.2      define aggregate, molecule, crystal and metal
- compare molecular crystals and ionic crystals
- recall and give examples of the categories of aggregates (molecular, ionic, metallic, covalent)
- 12A.3.3.a    define ionic crystal
- draw three dimensional diagrams of ionic crystals ( $\text{Na}^+\text{Cl}^-$ ,  $\text{Mg}^{2+}\text{O}^{2-}$ )
- explain the relative proportions of each ion in a crystal by referring to the charges on their respective ions
- state how an ionic crystal is formed
- describe the major physical properties of ionic solids
- recall that an empirical formula for an ionic crystal represents an ion pair in an aggregate
- 12A.3.3.b    define electrovalence (ionic valence)
- describe the ionic crystal in terms of bonding forces
- predict which elements will tend to combine by electrovalence (ionic valence)
- 12A.3.3.c    define: electrostatic attraction, ionic bond
- illustrate the bonding forces in ionic aggregates using Lewis diagrams

- 12A.3.4.a      define molecule
- state the full meaning of a symbol and a formula in chemistry
- explain the difference between a molecular formula and a structural formula
- explain what is meant by "binary compound"
- define a diatomic and a triatomic molecule
- state the number of each type of atom in a molecule given its formula
- 12A.3.4.b      define covalent bond
- use Lewis (electron dot) diagrams to illustrate electron distribution in covalent molecules
- predict which elements will tend to combine by covalence using a periodic table
- explain how a hydrogen atom forms a covalent bond with another hydrogen atom
- explain why a helium atom is unlikely to form a covalent bond with another helium atom
- illustrate covalent bonding with the orbital box representation
- 12A.3.4.c      explain the meaning of single, double and triple covalent bonding and give an example of each
- draw Lewis (electron dot) diagrams for simple molecules and ions e.g.  $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{H}_2$ ,  $\text{Cl}^-$ ,  $\text{OH}^-$
- draw line diagrams for simple molecules and ions, e.g.  $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{H}_2$ ,  $\text{OH}^-$
- 12A.3.4.d      draw Lewis (electron dot) diagrams for compounds with double or triple bonds as well as compound where the "octet" rule does not apply

- 12A.3.4.e explain both types of valence (covalence and electrovalence) in terms of atoms tending to reach the stable electron configuration of noble gas (stable octet)
- define covalence and predict it from the outer shell of an atom
- predict the combining power or covalency of a particle in a molecule
- 12A.3.4.f understand that work must be done to break a molecule into its constituent atoms
- 12A.3.5.a apply the knowledge of the covalency of carbon to the packing of carbon in diamond and graphite
- 12A.3.5.b give some examples of solid covalent crystals
- describe the two types of forces acting in a covalent crystal
- state the nature of the particle and the type of bonding in a covalent aggregate
- infer the properties of a covalent aggregate from the knowledge of its structure
- describe the properties typical of compounds possessing bonding of the following types
- a) ionic,
- b) covalent network solid
- 12A.3.5.c explain the hardness of gems and minerals
- 12A.3.6.a state the nature of the particle and the type of bonding in metals
- infer the properties of metals from the knowledge of their structure
- explain metallic properties from the theoretical structure
- explain how the the bonding affects the physical properties of metals

- 12A.3.6.b      describe the structure of a piece of metal
- explain using a diagram how the bonding in metals  
                 differs from the bonding in most other crystals
- 12A.3.7          illustrate, using diagrams, the structure of  
                 phosphorus and sulfur
- describe the structure of a simple ionic crystal
- explain the shape of a water molecule

STATES OF MATTER

UNIT IV

Upon completion of this topic, the student should be able to:

- 12A.4.1        explain the difference in properties between solids, liquids and gases using the kinetic molecular theory
- explain the difference in densities of solids, liquids and gases by referring to the force of attraction between particles
- sketch the relative distances between particles in solids, liquids and gases
- define translational, rotational, and vibrational energy
- state the types of molecular motion predominant in each state of matter.
- sketch the types of molecular motion predominant in each state of matter
- name each of the changes of state matter can undergo and indicate whether energy is absorbed or emitted
- explain some properties of solids, liquids and gases by referring to their particle nature
- explain what is meant by an elastic collision
- 12A.4.2.a      list the properties of the solid phase
- relate the properties of the solid phase to the kinetic molecular theory
- compare the average kinetic energy of molecules in solids, liquids and gases
- 12A.4.2.b      list and give examples of the types of components (similar atoms, different atoms, molecules, ions) in the solid phase

- 12A.4.2.c describe potential energy ( $E_p$ ) and kinetic energy ( $E_k$ ) changes with changes of state
- explain the relationship between temperature and average kinetic energy
- state the relationship between melting point and intermolecular forces
- define and give an example of sublimation
- state the relationship between vibrational energy and temperature
- define melting point in terms of the kinetic molecular theory
- explain, using the kinetic molecular theory, why heat energy travels from a hotter body to a cooler body
- distinguish between the terms heat and temperature
- explain the terms: a) molar heat of vaporization  
b) molar heat of fusion  
by referring to attractive forces between particles
- state the values of molar heat of vaporization, and molar heat of fusion for water
- 12A.4.2.d design and/or perform an experiment to illustrate sublimation
- define non-crystalline solid
- differentiate between crystalline and non-crystalline solids
- 12A.4.3.a list the properties of liquids
- outline the differences in translational energy of the particles of a liquid and gas at the same temperature
- relate the properties of liquids to the kinetic molecular theory
- 12A.4.3.b explain using the kinetic molecular theory how the volume of a liquid changes with temperature
- recall that temperature is indicative of the average kinetic energy of particles
- recall that in a given volume of gas at a given temperature there is a distribution of speeds of particles and hence distribution of kinetic energies of particles

explain using the kinetic molecular theory why the volume of a liquid changes with temperature

12A.4.3.c      define vaporization

define evaporation in terms of energy

explain cooling effect using the kinetic molecular theory

define heat of vaporization.

explain the cooling effect of a liquid when it evaporates

12A.4.3.d      differentiate between partial pressure and vapour pressure

explain how condensation causes a release of heat

define the vapour pressure of a liquid

determine dry gas pressure from experimental data

explain why liquids boil under reduced pressure

explain, using the kinetic molecular theory, what happens to the vapour pressure of any liquid when heated

define the terms saturation and vapour pressure

predict what happens to the boiling point of a pure substance as the atmospheric pressure is increased

define what is meant by the "standard" boiling point of a liquid.

predict which substance is most likely to have the lowest or highest boiling point from a list of vapour pressures of different substances at 25°C

explain the high boiling points of some metals (Fe,Cu) and the low melting points of some compounds ( $H_2O$ ,  $CCl_4$ ) by referring to forces between particles

- 12A.4.4.a      relate the properties of a substance in the gas phase to the kinetic molecular theory
- explain the pressure of a gas in terms of the kinetic molecular theory
- state how the average kinetic energy of a gaseous substance varies with the temperature and the molar mass of the gas
- measure the pressure of a gas using a barometer or manometer
- explain the cause of gaseous pressure using the kinetic molecular theory
- state the effect of temperature, number of molecules, mass and volume on the pressure of a gas
- 12A.4.4.b      explain the relationship between speed, kinetic energy and temperature
- perform and/or design an experiment to illustrate the relative rate of diffusion of different gases, e.g. hydrogen chloride and ammonia
- 12A.4.4.c      state Avogadro's Principle
- explain Avogadro's Principle using the kinetic molecular theory
- 12A.4.4.d      state Boyle's Law
- explain Boyle's Law using the kinetic molecular theory
- perform and/or design an experiment to illustrate Boyle's Law.

12A.4.4.e state Charles' Law

explain Charles' Law using the kinetic molecular theory

perform and/or design an experiment to illustrate Charles' Law

explain the concept of absolute zero

draw pressure - temperature graphs illustrating Charles' Law from experimental data

derive the absolute zero statistically

perform conversions from the Celsius temperature scale to the Kelvin temperature scale

12A.4.4.f define standard temperature and pressure (S.T.P.)

solve simple problems using Dalton's Law of Partial Pressures

solve problems using Boyle's and Charles' Laws separately and combined

calculate partial pressures

calculate the density of a gas - (a) at STP, (b) at other temperatures and pressures

describe the relationship between the density of a gas and the applied temperature and pressure in terms of the kinetic molecular theory

state Dalton's Law of Partial Pressures

name four factors (density, temperature, volume, quantity) accounting for the changes in pressure of gas

explain how the four factors (density, temperature, volume, quantity) cause changes in pressure of a gas

draw a labelled diagram of a mercury barometer

define a mole as Avogadro's number (N) of particles

explain what is meant by the term "air pressure"

state the percentages by volume of gases in the atmosphere

state Dalton's Law of Partial Pressure and use it in calculating pressures in a mixture of different gases

calculate the relative average velocities of two different gases given their chemical formulae and a periodic table

given the partial pressures of a mixture of gases in a sample, determine the relative number of each type of gas particle present

derive the limited gas law equation given sample data from Boyle's, Charles' and the Pressure-Temperature law experiment

list five major assumptions forming the basis of the kinetic molecular theory and cite at least one experiment or phenomenon that supports each assumption

OXYGEN AND HYDROGEN: AN INTRODUCTION TO CHEMICAL REACTIONS

UNIT V

Upon completion of this topic, the student should be able to:

12A.5.1        define reaction, reactant, product, exothermic, endothermic

distinguish between reactant and product given a word equation

distinguish between endothermic and exothermic given a written description of the energy change in the reaction

relate the energy change in a chemical reaction to form more (or less) stable compounds

12A.5.2        define chemical equation

write word equations given a list of reactants and products

relate chemical equations to conservation of mass

12A.5.3.a      list the forms in which oxygen can occur in nature

recall the % of free oxygen in the atmosphere

recall the abundance of oxygen both free and combined

relate the occurrence of free oxygen in the atmosphere to photosynthesis

describe a procedure to measure free  $O_2$  in the atmosphere

design and/or perform an experiment to measure free  $O_2$  in the atmosphere

write word equations for the conversion of  $CO_2$  to  $O_2$  during photosynthesis

relate the increase in atmospheric  $CO_2$  to removal of forest stands and the increased use of fossil fuels

- 12A.5.3.b design and/or perform an experiment to prepare oxygen gas in the lab
- describe the laboratory preparation of  $O_2$  gas
- experimentally determine the properties of oxygen
- recall the physical properties of  $O_{2(g)}$
- 12A.5.3.c describe commercial methods of preparing oxygen
- 12A.5.4.a define oxidation, oxides, combustion
- design and/or perform an experiment to prepare oxides from the elements
- state the assumptions of the modern theory of combustion
- identify the products of combustion of elements
- list the 3 factors required for combustion
- a) fuel b) kindling temperature c) oxygen
- 12A.5.4.b list the products of the complete combustion of carbonaceous substances
- design and/or perform an experiment to determine the products of the complete combustion of carbonaceous substances
- distinguish between complete and incomplete combustion
- 12A.5.4.c define kindling temperature
- describe the energy changes involved in combustion
- design and/or perform an experiment to determine the relative amounts of heat evolved by the combustion of various substances
- relate the amount of heat evolved in combustion to the type of reaction

- 12A.5.4.d      compare slow oxidation to combustion
- define spontaneous combustion
- outline from a demonstration, the spontaneous combustion of white phosphorus
- design and/or perform an experiment to the rates of oxidation of various metals
- describe the importance of oxide coating on metals such as aluminum
- 
- 12A.5.5.a      define acidic and basic anhydrides
- distinguish between and classify oxides (acid, basic, amphoteric)
- design and/or perform an experiment to prepare and study the properties of acidic, basic, and amphoteric oxides
- 
- 12A.5.5.b      define: acid, base
- 
- 12A.5.6.a      prepare solutions and carry out calculations required to determine the percent dissolved oxygen in water
- 
- 12A.5.6.b      list industrial uses of oxygen
- 
- 12A.5.6.c      list medical uses of oxygen
- 
- 12A.5.6.d      explain how pure liquid oxygen is used in rocket fuels
- 
- 12A.5.7.a      recall the relative abundance of free hydrogen in the universe and on earth
- recall the natural occurrence of combined hydrogen
- 
- 12A.5.7.b      design and/or perform experiments to prepare hydrogen gas

- 12A.5.7.c describe the commercial techniques of preparing hydrogen
- 12A.5.8.a design and/or perform an experiment to determine the properties of hydrogen
- 12A.5.8.b explain the reduction of metal oxides using hydrogen  
define reversible reaction
- 12A.5.9 design and/or perform an experiment to determine the relative activities of metals from their reactions with oxygen and acids

# THE MOLE, ATOMIC WEIGHTS, AND MOLECULAR WEIGHTS

## UNIT VI

Upon completion of this topic, a student should be able to:

- 12A.6.1        define the mole
  - state Avogadro's number (N)
  - relate N to a mole of a substance
  - compare and contrast two chemical definitions for the term "mole"
  - explain the purpose of using the mole concept
  
- 12A.6.2.a     illustrate, with a diagram, the operation of a mass spectrometer
  - calculate the relative atomic mass of an element from the % abundance obtained from mass spectrometer data and the mass numbers of the respective isotopes
  
- 12A.6.2.b     define: molar atomic mass
  - state the mathematical relationship between relative atomic mass and molar atomic mass
  - solve problems involving the number of moles of an element, the mass and relative atomic mass of the element
  - determine the relative atomic mass of any element given a Periodic Table
  
- 12A.6.3.a     define relative molecular mass and molar mass of elements and compounds
  - distinguish between relative molecular mass and molar mass
  - distinguish between molar mass and molar atomic mass of an element

- 12A.6.3.b      express molar mass in terms of measurable mass units
- calculate the mass of a mole of molecules, given the  
                 formula of a pure substance
- calculate the number of particles in a given number  
                 of moles of a substance
- calculate the number of moles of a substance in a  
                 given mass of the substance
- recognize N, Avogadro's Number
- solve problems involving the number of moles, the  
                 relative molecular mass and the formula of a pure  
                 substance
- 12A.6.3.c      state Avogadro's Principle
- apply Avogadro's Principle to numerical calculations
- compare the ratio, by mass, of equal volumes of various  
                 gases
- define molar volume
- 12A.6.3.d      recognize the significance of 22.4 L at STP
- solve problems involving molar volume,  
                 relative molecular mass and chemical formulae
- 12A.6.3.e      calculate relative molecular mass from the formulae  
                 of compounds and tables of relative atomic masses
- calculate relative molecular masses from mass,  
                 volume, temperature and pressure data for gases
- design and perform experiments to measure the  
                 relative molecular masses of gaseous pure  
                 substances
- 12A.6.4.a      calculate the composition, by mass, of a compound  
                 from the formula

- 12A.6.4.b      calculate the simplest (empirical) formula of a compound from the composition, by mass
- calculate the simplest (empirical) formula of a compound from the % composition, by mass
- calculate the simplest (empirical) formula of a compound from experimental data (synthesis, analysis)
- 12A.6.4.c      distinguish between simplest formula and molecular formula
- recognize that simplest formula is a "subset" of molecular formula
- calculate molecular formula from simplest formula and relative molecular mass
- calculate molecular formula of gases from simplest formula and mass and volume data
- calculate molecular formula of pure substances from appropriate experimental data
- decide which experimental data must be determined in order to calculate the molecular formula of a pure substance
- design and perform experiments to collect the data necessary to calculate the molecular formula of a pure substance
- 12A.6.4.d      calculate the number of atoms in a given mass of a pure substance
- 12a.6.4.e      calculate the relative molecular mass of a pure substance, given the mass of a number of molecules of a pure substance
- 12a.6.4.f      solve problems involving relative molecular mass, mass, volume, temperature and pressure of a gas
- design and prepare experiments to measure and/or calculate one or more of relative molecular mass, mass, volume, temperature and pressure of a sample of a gaseous pure substance
- 12A.6.4.g      calculate the concentration of molecules in a given mass and volume of a gas

## FORMULAS, NOMENCLATURE, AND EQUATIONS

### UNIT VII

Upon completion of this topic, the student should be able to:

- 12A.7      relate the mole concept to chemical formulae and chemical equations
- given the masses of two reactants in a reaction for which the equation is known, determine which reactant is in excess
- calculate a % yield, given the yield and the equation
- determine the limiting reagent in a reaction
- calculate the amounts of reactants required for a reaction, given the quantity of one reactant
- predict the yield, given the equation and the quantity of reactant
- determine the molar volume of the gas produced at STP
- given a balanced chemical equation, list the
- a) number of individual particles represented by the equation on a microscopic scale
- b) number of moles of particles represented by the equation on a macroscopic scale
- convert chemical equations to word equations
- convert word equations to chemical equations
- understand the Law of Conversation of Mass as it relates to balancing equations
- balance equations by inspection
- write ionic equations representing ionization of elements during the formation of ionic compounds
- explain the procedure for balancing equations
- given data on numbers of atoms reacting as well as numbers of grams of reactants, calculate the relative masses of the atoms
- given the formula of a hydrocarbon, write a balanced chemical equation for its combustion (complete or incomplete)
- determine the proper coefficients to balance a chemical equation
- solve problems involving chemical equations by using the mole concept

write equations, using Lewis (electron dot) diagrams and formulas, for the formation of ionic and covalent compounds

given a balanced equation and the number of grams or moles in one substance involved in the reaction, calculate the corresponding number of grams or moles of any other substance appearing in the equation

write a word equation, skeleton equation and balanced chemical equation given the reactants and products of the reaction

state the full meaning of a chemical equation

solve problems involving an excess of one reactant

state what information is not found in chemical equations

state the information which a chemical equation imparts

write and interpret simple chemical equations

state whether or not an equation is

- a) mass balanced
- b) charge balanced

12A.7.1.a      write the names of the common elements, given the respective symbols for the elements.

write the symbols of the common elements, given the respective names of the elements

explain the order of the symbols in the formula of binary compounds

12A.7.1.b      write the names of the common compound ions given their respective formulae

write the formulae of the common compound ions given their respective names

write the names and formulae of simple compound ions

12A.7.1.c      name and write the formulae for compound ions derived from the oxy/acids

12A.7.2.a      write the valence of common elements and compound ions

list common elements and compound ions with a given valence

- 12A.7.2.b      determine the valence of the common elements, given the formula of a binary compound
- distinguish between the valences of common multivalent elements, given the formula of binary compounds
- write names of compounds using IUPAC nomenclature
- calculate the formulae of binary compounds from data determined experimentally by the analysis of the binary compounds
- calculate the formulae of binary compounds from data determined experimentally by the synthesis of binary compounds
- perform and/or design experiments to determine the formulae of binary compounds
- 12A.7.2.c      write the names of the binary compounds of the common elements using IUPAC nomenclature  
                 e.g.  $\text{CaCl}_2$  calcium chloride
- write the formula of the binary compounds of the common elements given the IUPAC names  
                 e.g. calcium chloride  $\text{CaCl}_2$
- write the names of binary compounds of the multivalent elements using the IUPAC (Stock) nomenclature e.g.  $\text{FeCl}_2$  iron (II) chloride
- write the names using the IUPAC prefix nomenclature of binary compounds of the multivalent elements  
                 e.g.  $\text{FeCl}_2$  iron dichloride
- write the names using OUS-IC suffix nomenclature of binary compounds of the common elements  
                 e.g.  $\text{FeCl}_2$  ferrous chloride
- write the formulae of binary compounds of the multivalent elements given the names of the compounds in one or more of  
                 (i) IUPAC (Stock) nomenclature - e.g.- iron (II) chloride  
                 (ii) IUPAC (prefix) nomenclature - e.g. - iron dichloride  
                 (iii) OUS-IC (suffix) nomenclature - e.g. - ferrous chloride
- write the names of binary acids, given the formulae of binary acids
- write the formulae of binary acids, given the names of binary acids

write the formulae of oxy-acids given the names in one or more of nomenclature systems

write the names of the oxy-acids in one or more the nomenclature systems

write the names and formulae of metal salts of the oxy-acids. The names to be written in one or more of the nomenclature systems

write the names and formulae of hydrates

calculate the % composition, by mass, of hydrates

design and/or perform experiments to determine the formulae of hydrates

predict the appropriate whole numbers in formulae calculated from experimental data

12A.7.2.d      determine the valence of common elements according to position in the Periodic Table

select elements with specific valence, according to position in the Periodic Table

predict the valence of common elements given the atomic structure

predict the valence of common elements given the number of electrons in the valence level

explain the relationship between valence and atomic structure of the common elements

predict the existence and formulae of compounds based on the position of elements in the Periodic Table

predict the formation of compounds based on the atomic structure of the common elements

- 12A.7.3.a list the information obtainable from an unbalanced (skeleton) chemical equation
- list the information obtainable from the formula of an element or compound
- recognize a chemical equation as balanced or unbalanced
- balance chemical equations by inspection
- balance chemical equations algebraically
- relate balanced chemical equations to conservation of
- (i) mass
  - (ii) volume
  - (iii) energy
  - (iv) atoms
  - (v) molecules
  - (vi) moles
  - (vii) ions
  - (viii) charge
- 12A.7.3.b list the information obtainable from balanced chemical equations
- determine the molar ratios of reactants and products from a balanced chemical equation

## WATER AND SOLUTIONS

### UNIT VIII

Upon completion of this topic, the student should be able to:

- 12A.8.1.a      list places where water may be found free in nature  
list the common names for the various states of water  
list household and industrial uses of water  
evaluate importance of water  
discuss the problems of acid rain on the environment
- 12A.8.1.b      list some chemical properties of water  
state the physical properties of water  
state the effect of temperature on the density of water  
state the effect of temperature on the volume of water  
state the effect of temperature on the vapour pressure of water
- 12A.8.1.c      list instances where water is used as a reference standard  
state why water is used as a reference standard
- 12A.8.1.d      determine the composition by volume of water using electrolysis  
state the composition of water by volume and by mass
- 12A.8.1.e      demonstrate the presence of water in a hydrate (experimentally)  
design and/or perform an experiment to determine the mass of water in a hydrate  
describe the crystal structure of a hydrate  
define efflorescence  
list uses of efflorescent substances  
calculate the percentage by mass of water in hydrates, given the molecular formula

calculate the formula of a hydrate from percentage by mass calculation

write a chemical equation to show the products of the thermal decomposition of a hydrated salt

write a chemical equation to show the formation of a hydrated salt from its anhydrous counterpart

- 12A.8.1.f      define hygroscopic substance
- define deliquescent substance
- list uses of hygroscopic and deliquescent substances
- 12A.8.2.a      define solution
- give examples of solutions
- define solvent
- give examples of solvents
- define solute
- give examples of solutes
- list the characteristics of a solution
- define miscible
- differentiate between solutions and pure substances
- differentiate between solutions and mechanical mixtures
- explain why the components of a solution can be separated by the process of distillation
- 12A.8.2.b      list examples of solutions formed by a solid dissolved in a liquid
- list examples of solutions formed by a liquid dissolved in a liquid
- list examples of solutions formed by a gas dissolved in a liquid
- list examples of solutions formed by a gas dissolved in a gas

list examples of solutions formed by a liquid dissolved in a gas

list examples of solutions formed by a solid dissolved in a gas

list examples of solutions formed by a liquid dissolved in a solid

list examples of solutions formed by a solid dissolved in a solid

define unsaturated

define saturated

define supersaturated

give an example of a dilute saturated solution

differentiate between a concentrated and a dilute solution

12A.8.2.c calculate the mass of the solution, given the density (or specific gravity) and volume of a solution

describe the effect of temperature on solubility

calculate the volume of a solution of known concentration that contains a given mass in grams of solute

calculate the molar concentration given the mass of the solute and the volume of the solution

calculate the number of grams of solute in a given volume of solution of known concentration

12A.8.2.c calculate the volume of a solution of known concentration that will contain a desired number of moles of solute

state factors affecting solubility and rate of solubility

calculate the solubility in g/100 mL or g/L or kg/m<sup>3</sup> of solution given the mass of solute to saturate a given volume of solution at a given temperature

determine the number of moles of solute present from the mass and chemical formula of a solute and the volume of a solution

determine molar concentration of solution ( $\text{mol/L}$  or  $\text{mol/m}^3$ ) given the mass and chemical formula of a solute, and the volume of a solution

define molar concentration

calculate the amount of solute required to prepare a solution of required molar concentration

describe the preparation of a supersaturated solution

design and/or perform an experiment to prepare a laboratory solution of desired concentration using a volumetric flask, and chemical balance

define percent by mass

transfer liquids accurately using pipettes and burettes

calculate the mass of solute and solvent, given the percent by mass and the total mass

## IONS IN AQUEOUS SOLUTION

### UNIT IX

Upon completion of this topic, the student should be able to:

- 12A.9.1.a      perform an experiment to measure the relative conductivities of aqueous solutions, pure liquids and metals
- explain the conductivity of aqueous solutions in terms of mobile ions
- state the relative conductivities of metals, aqueous solutions and pure liquids
- 12A.9.1.b      define electrolyte
- define non-electrolyte
- classify substances as electrolytes or non-electrolytes given the relative conductivities of their aqueous solutions
- 12A.9.1.c      explain that water is a weak electrolyte because of slight dissociation into ions
- describe the process occurring during the formation of a solution according to the kinetic molecular theory
- given the names and/or formulae of the solute and solvent components of a solution, defend or refute the hypothesis that the solution will conduct electricity, basing your arguments on the electrical and structural makeup of the solution
- define what is meant by a solvated ion
- identify and predict some of the properties of solvated ions
- calculate the molar concentration of an ion from molar concentration of the compound of which it is a part
- describe what is meant by dissociation and ionization in an aqueous medium
- given the formula of a solute and/or its aggregate structure, state the type or types of bonds which will be disrupted when the solute dissolves

predict the ratio of ions present in a solution of that compound, and predict the charge on each ion given a simple compound, (known to form ions in solution)

explain reasons for "like dissolving like"

explain with examples the difference between ionization and dissociation

write ionization equations for ionic compounds and for polar covalent compounds such  $\text{HCl}$  and  $\text{NH}_3$  in water

discuss the action of polar water molecules on ionic compounds (ionization) and the process of dissociation into ions involving water and molecular compounds

write equations to show the formation of ions from

- a) fused ionic compounds
- b) aqueous solutions of ionic compounds
- c) acids and water

12A.9.2.a give a general description of an electrolytic cell and its operation

list contributions of Arrhenius to the modern theory of electrolytes

state that ions carry electric current through an electrolyte and that electrons carry electric current through a solid conductor

define

- |                 |                    |
|-----------------|--------------------|
| a) electrolysis | (i) oxidation      |
| b) electrode    | (j) reduction      |
| c) anode        | (k) anion          |
| d) cathode      | (l) cation         |
| e) electrolyte  | (m) electroplating |

state that oxidation occurs at the anode

12A.9.2.b recognize that all soluble acids, bases and salts conduct electricity in water solution

recall the products of the electrolysis of hydrochloric acid, copper (II) sulfate solution, sodium chloride solution and water containing some potassium nitrate or sulfuric acids

state that oxidation is a loss of electrons (LEO)

design and/or perform an experiment to illustrate electroplating

state that reduction is a gain of electrons (GER)

12A.9.2.c

state that reduction occurs at the cathode

explain the conductivity of certain solutions

list a simple electrochemical series

write ionic equations involving elements on the electrochemical series

use the electrochemical series to predict whether certain ionic equations are probable

recognize redox as reactions involving electron transfer

explain conductivity in aqueous solutions in terms of mobile ions

explain why more electrical current is required to neutralize one mole of aluminum ions than one mole of sodium ions

distinguish between electrolytes and non-electrolytes

predict the conductivity of a solution knowing the formula of the solute

give one example of a solute which is a electrolyte in one solvent but a non electrolyte in a second solvent

recognize redox reactions given a list of equations

state the postulates of the modern theory of electrolytes

recognize the oxidizing and reducing agents in given redox reactions

describe how electrolysis is applied industrially in areas of a) electro-plating b) purification of metals c) production of sodium hydroxide

describe the transfer of electrons in a given redox reaction

identify the process of oxidation and reduction using oxidation states, in redox reactions

describe the theoretical basis of electrolysis, in terms of oxidation - reduction

design and/or perform an experiment on the electrolysis of certain compounds

do the following for a given electrolysis process:

- a) determine the types of anions and cations present in a particular liquid,
- b) indicate on a diagram which ions move to which electrode,
- c) give the balanced chemical half-reaction which occurs at each electrode,
- d) identify the oxidizing and reducing agents
- e) identify the process at each electrode as oxidation or reaction
- f) give the balanced overall electrolysis reaction (overall cell reaction)

explain why molecular solids such as sugar do not conduct electricity when dissolved

explain why solid sodium chloride does not conduct electricity whereas aqueous sodium chloride does conduct

explain, with examples, the meaning of the terms strong vs weak electrolyte and dilute vs concentrated solution

give examples of a strong but dilute solution and a weak yet concentrated solution.

explain with examples the term electrolyte and non electrolyte

write ionic dissociation and ionization equations to show the formation of mobile ions in water from salts, hydroxides and acids

briefly describe how an electrolyte could be distinguished experimentally from a non-electrolyte and explain the results of the experiment using examples

state and explain the relative electrical conductivities of metals, pure water, and various solutions and compounds

12A.9.3.a design and/or perform an experiment to order the activity of metals, given samples of the metals and solutions of salts of the same metals

given a periodic table and an electrochemical series write net ionic equations representing any reactions which occur between any metal on the series and the salt of another metal on the series. (Where more than one equation may be written, both should be shown to satisfy this objective.)

list information gained from an activity table of metals

define redox

recall information which can be derived from a simple electrochemical series

use a simple electrochemical series to help predict whether a displacement reaction will go to completion

design and/or perform an experiment to illustrate the meaning of oxidation and reduction

12A.9.4.a identify some common cations by their colour in aqueous solution

12A.9.4.b define hydronium ion as an hydrated hydrogen ion

explain the formation of the hydronium ion

recall the Arrhenius definition of an acidic solution

determine whether a solution is acidic given a list of its properties

state whether a solution is acidic, basic or neutral when given the pH

name some common lab acids

list the approximate pH of some common substances

list the properties of aqueous acid solutions

list some physical and chemical properties of acids and bases

explain the meaning and use of the pH scale

design and/or perform experiments to study the properties of a) acids, b) bases

- 12A.9.5.a      describe proper titration techniques
- write balanced chemical and ionic equations to  
                 show neutralization
- arrange the results of an acid-base titration in  
                 proper chart form
- identify some common indicators used in identifying  
                 whether a solution is acidic, basic or neutral  
                 (litmus paper, phenolphthalein, bromthymol blue)
- explain the purpose of a standard solution in a  
                 titration
- state the purpose of an indicator in a titration
- calculate the concentration of one substance in  
                 an acid-base titration when given the volume of  
                 that substance and the volume and concentration of  
                 the other substance
- state the purpose for a titration
- perform an acid-base titration with an accuracy  
                 of  $\pm .05$  mL
- describe the principle of titration in quantitative  
                 analysis
- write ionic equations for the neutralization  
                 reactions of strong acids and bases
- describe the effect of acids and bases on litmus  
                 and bromthymol blue indicators
- describe ways to neutralize an acid
- describe the reaction of acids and bases with  
                 litmus, bromthymol blue, and phenolphthalein  
                 indicators
- 12A.9.5.b      write equations showing the step-wise disassociation  
                 of a polyprotic acid into ions
- 12A.9.5.c      name common acid salts from given chemical formulae
- identify whether a substance is an acid, base or  
                 salt when given a chemical formula for the substance
- write chemical formulae for common acid salts given  
                 the IUPAC names

- 12A.9.6 identify and predict the products given certain ions in an aqueous medium
- identify a reaction that goes to completion
- 12A.9.6.a write ionic equations (full and net) for reactions given solubilities of reactants and products
- predict whether or not a precipitate will occur and write balanced equations for the precipitate reaction, when two or more solutions containing various cations and anions are mixed
- perform an experiment to illustrate the formation of very slightly soluble salts
- predict the type of reaction taking place in an aqueous medium from the interaction between certain given ions
- write the equation for a reaction between ionic solutions given the names of the solutes
- identify the presence of certain ions in solution given known and unknown solutions
- 12A.9.6.b design and/or perform an experiment to illustrate the formation of gases of low solubility
- 12A.9.6.d list common metals and hydrogen in an activity series
- design and/or perform an experiment to set up an activity table of metals

ELEMENTS OF GROUP TWO  
(The Alkaline Earths)

UNIT X

Upon completion of this topic, the student should be able to:

12A.10.1.a

12A.10.1.b outline the natural occurrence of the alkaline earths

12A.10.1.c

12A.10.1.d outline the common physical properties of the alkaline earths

12A.10.1.e outline the common chemical properties of the alkaline earths

describe the action of calcium on water

compare the action of calcium to that of sodium on water

describe the reaction of magnesium with steam

describe the reaction of an alkaline earth element with acids

design and/or perform an experiment on alkaline earth metals with acids

12A.10.1.f write the electron configuration for an alkaline earth oxide

describe the bonding in alkaline earth oxides

design and/or perform an experiment of an alkaline earth oxide with water

write the equation of an alkaline earth oxide with water

describe several uses of alkaline earth oxides

12A.10.1.g write the equation for the production of an alkaline earth carbonate from its hydroxide

write the equation for the production of an alkaline earth carbonate from its hydrogen carbonate

state some common properties of alkaline earth carbonates

design and/or perform an experiment illustrating the production of an alkaline earth carbonate from its oxide

design and/or perform an experiment illustrating the production of an alkaline earth carbonate from its hydroxide

design and/or perform an experiment illustrating the the production of an alkaline earth carbonate from its hydrogen carbonate

design and/or perform an experiment illustrating common properties of alkaline earth carbonates

12A.10.1.h define: hard water, soft water temporary hardness, permanent hardness, ion exchange, soap and detergent

distinguish between a soap and a detergent

write a chemical equation showing the formation of temporary hardness in water

write a chemical equation showing the formation of permanent hardness in water

explain the method of removal of temporary hardness in water

explain the method of removal of permanent hardness in water.

state the common use of alkaline earth sulfates

12A.10.2 explain the similarities of the alkaline earth metals by referring to their electronic arrangement

12A.10.3 state and explain the trend in reactivities of the group 2 elements

## ELEMENTS OF GROUP SEVEN

### UNIT XI

Upon completion of this topic, the student should be able to:

- 12A.11.1.a    define halide, halogen  
                 describe the relative abundance of the halides
- 12A.11.1.b    list physical properties of sodium and potassium  
                 halides
- 12A.11.1.c    experimentally determine the properties of the  
                 silver halides  
                 design and/or perform an experiment to determine  
                 the relative solubilities of silver halides  
                 compare the solubilities of the silver halides in  
                 water and aqueous ammonia
- 12A.11.1.d    describe the preparation of the hydrogen halides  
                 list the physical properties of the hydrogen halides  
                 list the properties of aqueous solutions of the  
                 hydrogen halides
- 12A.11.2.a    describe the production of the halogens  
                 write word equations for the production of the  
                 halogens
- 12A.11.2.b    design and/or perform an experiment to prepare  
                 chlorine, bromine and iodine  
                 list the properties of chlorine, bromine and iodine  
                 arrange the halogens according to relative reactivity  
                 experimentally determine the relative strength of the  
                 halogens as oxidizing agents
- 12A.11.2.c    list the properties of fluorine  
                 relate the properties of fluorine to its position  
                 in the periodic table and its electronic structure  
                 list uses of HF and NaF
- 12A.11.2.d    predict the properties of astatine

## PERIODIC CLASSIFICATION OF THE ELEMENTS

### UNIT XII

Upon completion of this topic, the student should be able to:

- 12A.12.a      describe the arrangement of Mendeleev's table in terms of periods and families
- appreciate the benefits of classifying elements according to their chemical properties
- describe the arrangement of elements into periods and rows in the modern periodic table
- relate the position of an element on the periodic table to atomic structure
- locate on the periodic table, the metals and non-metals
- select from the periodic table on the basis of a knowledge of trends the:
- a) most metallic and most non-metallic elements
  - b) elements with the largest and smallest atomic size
  - d) elements with the highest and the lowest electronegativity
  - e) elements from Group 1 with the highest and lowest reactivity
  - f) elements from Group 7 with the highest and lowest reactivity
- 12A.12.b      predict the properties of an element, given data about other group members
- explain in terms of electronic configuration why elements in the same family have similar properties
- locate, on the periodic table, the noble gases, the alkali metals, the alkaline earths, and the halogens
- explain similarity in properties in families in terms of atomic structure
- predict whether an element is a metal, non-metal or noble gas
- explain trends in properties in periods in terms of atomic structure
- place elements into their proper families given their electronic structure
- relate position of elements on the periodic table to their electronic structure

12A.12.c relate the position in a period to filling of valence shells

12A.12.d relate the differences in a group to the variance in atomic size

use the periodic table to predict the properties of an element

12A.12.e

(b) S-17D MULTIPLE CHOICE INSTRUMENTS

12A.1.

- 1) A white solid which has a sharp, constant melting point is decomposed by electrolysis to give a greenish gas and a silvery solid. Attempts to decompose these two substances were not successful. The silvery solid and greenish gas are
  - \*A) elements from a compound
  - B) the components of a homogeneous mixture
  - C) elements from a homogeneous mixture
  - D) the components of a heterogeneous mixture
  
- 2) The field of chemistry concerned with the separation and quantitative determination of the composition of different substances is
  - A) physical chemistry
  - B) organic chemistry
  - \*C) analytical chemistry
  - D) biochemistry
  
- 3) An example of a gas at room temperature is
  - \*A)  $O_2$  (oxygen)
  - B) NaCl (sodium chloride)
  - C)  $C_{12}H_{22}O_{11}$  (sucrose)
  - D)  $H_2O$  (water)
  
- 4) How many significant digits are there in the number 0.002060?
  - A) six
  - B) two
  - C) three
  - \*D) four

12A.1.

- 5) The freezing point of mercury is 234 K and the freezing point of cadmium is 594 K. If you devised a temperature scale using the freezing point of mercury as  $0^{\circ}\text{N}$  and the freezing point of cadmium as  $100^{\circ}\text{N}$ , what would be the Kelvin temperature corresponding to  $90^{\circ}\text{N}$ ?
- A) 324 K
  - B) 527 K
  - \*C) 558 K
  - D) 597 K
- 6) The density of a liquid was found to be  $1.52 \pm 0.03 \text{ g/cm}^3$ . The mass of  $10.5 \pm 0.2 \text{ cm}^3$  of the liquid is
- A)  $16.0 \text{ g} \pm 1.42\%$
  - B)  $16.0 \text{ g} \pm 1.90\%$
  - C)  $16.0 \text{ g} \pm 1.97\%$
  - \*D)  $16.0 \text{ g} \pm 3.87\%$
- 7) A theory is best defined as
- A) a set of observations
  - B) an important experiment
  - C) a guess that cannot be tested
  - \*D) a model to explain observations
- 8) How many significant digits should be quoted in the product  $(4.6 \times 12.62)$ ?
- A) 5
  - \*B) 2
  - C) 3
  - D) 4

12A.1.

9) The mass of an empty beaker is  $125.3 \pm 0.2$  g. The mass of the beaker plus a sample of sugar is  $148.7 \pm 0.2$  g. The mass of the sugar sample is best represented by

- A) 23.2 g
- B)  $23.4 \pm 0.2$  g
- \*C)  $23.4 \pm 0.4$  g
- D) 23.6 g

10) Which one of the following statements represents a quantitative observation?

- A) The reactant was orange in colour.
- B) The product was very dense.
- C) The orange colour disappeared completely.
- \*D) The temperature in the test tube reached  $250^{\circ}\text{C}$

11) What pressure is exerted by a metal block of mass 10 kg and dimensions 10 cm x 10 cm x 10 cm on the table where it sits?

- A) 0.10 Pa
- \*B) 1.0 Pa
- C) 1.0 kPa
- D) 10 kPa

12) A scientific model is

- A) never altered
- \*B) altered to fit new observations
- C) a set of scientific laws
- D) altered to produce new laws

12A.1.

- 13) The mass of a sample of a metal is  $15.15 \pm 0.02$  g.  
The volume of the metal sample is  $1.152 \pm 0.003$  cm<sup>3</sup>.  
The density of the metal is

- A)  $13.15 \pm 0.02$  g/cm<sup>3</sup>
- B)  $13.15 \pm 0.023$  g/cm<sup>3</sup>
- \*C)  $13.15 \pm 0.05$  g/cm<sup>3</sup>
- D)  $13.15 \pm 0.35$  g/cm<sup>3</sup>

- 14) "A clear colourless gas that is less dense than air explodes when mixed with oxygen and heated to 2500°C." This statement is an example of

- A) a qualitative observation only
- B) a quantitative interpretation only
- \*C) a qualitative and quantitative observation
- D) a qualitative and quantitative interpretation

- 15) The fundamental unit of length in the metric system is the

- A) gram
- \*B) metre
- C) millimetre
- D) litre

- 16) The density of a solid was found to be  $4.82$  g/cm<sup>3</sup>  $\pm 2\%$ .  
The volume of  $25.3$  g  $\pm 3\%$  of the solid is

- A)  $5.25$  g  $\pm 0.7\%$
- B)  $5.25$  g  $\pm 2\%$
- C)  $5.25$  g  $\pm 3\%$
- \*D)  $5.25$  g  $\pm 5\%$

12A.1.

17) Which of the following statements about oxygen describe physical properties of oxygen?

- I) Oxygen has a density of 1.43 g/L at STP.
- II) Oxygen supports the burning of magnesium.
- III) The melting point of oxygen is  $-218^{\circ}\text{C}$ .
- IV) Carbon combines with oxygen to form carbon dioxide gas.
- V) Oxygen reacts with iron to form rust.

- A) I only
- \*B) I and III
- C) I, II and III
- D) II, IV and V

18) To calculate pressure in pascals, the correct force and area units are

- A) g and  $\text{cm}^2$
- B) kg and  $\text{m}^2$
- C) N and  $\text{cm}^2$
- \*D) N and  $\text{m}^2$

19) The mass of a sheet of filter paper is measured to be  $0.22 \pm 0.02$  g. The mass of 4 sheets of filter paper is calculated to be

- A)  $0.88 \text{ g} \pm 0.02 \text{ g}$
- B)  $0.88 \text{ g} \pm 0.02\%$
- \*C)  $0.88 \text{ g} \pm 0.08 \text{ g}$
- D)  $0.88 \text{ g} \pm 2.7\%$

20) Models are used by scientists to

- \*A) explain observations
- B) explain future events
- C) verify scientific theories
- D) verify scientific laws

12A.1.

21) Scientific laws are generalizations

- A) designed to fit scientific theories
- \*B) derived from the results of experiments
- C) derived from models to explain nature
- D) designed to verify models

22) By experiment, a student found that 39.08%, by mass, of  $\text{KClO}_3$  (potassium chlorate) is oxygen. The accepted value is 39.17%. The % experimental error is

- A)  $\frac{39.08 - 39.17}{39.08} \times 100\%$
- \*B)  $\frac{39.08 - 39.17}{39.17} \times 100\%$
- C)  $(39.08 - 39.17) \times 100\%$
- D)  $(39.17 - 39.08) \times 100\%$

23) In which of the following experimental measurements is the percentage uncertainty the greatest?

- \*A)  $0.68 \pm 0.01 \text{ g}$
- B)  $4.08 \pm 0.01 \text{ g}$
- C)  $24.5 \pm 0.2 \text{ g}$
- D)  $278 \pm 0.01 \text{ g}$

12A.1.

24) Which of the following statements about oxygen are qualitative?

- I) Oxygen has a density of 1.43 g/L at STP.
- II) Oxygen supports the burning of magnesium.
- III) The melting point of oxygen is  $-218^{\circ}\text{C}$ .
- IV) Carbon combines with excess oxygen to form carbon dioxide gas.
- V) Oxygen reacts with iron to form rust.

- A) I and III
- B) V only
- C) II and IV
- \*D) II, IV and V

25) An example of a mixture is

- A) water
- B) sulphur
- C) carbon dioxide
- \*D) air

26) Air is classified as a mixture because it

- A) is a gas
- B) consists of pure substances
- \*C) has variable composition
- D) can be compressed

27) Which one of the following statements is true?

- A) All pure substances are elements.
- \*B) All compounds are pure substances.
- C) All compounds are mechanical mixtures.
- D) All pure substances are indivisible.

12A.1.

28) A mixture consists of substances associated in

- A) definite proportions
- B) equal proportions
- \*C) any proportions
- D) chemical combination

29) Which one of the following statements is true?

- A) As a solution of salt in water boils, the temperature decreases.
- \*B) Pure substances have constant physical and chemical properties.
- C) When the air above a liquid becomes "saturated" with vapour, the liquid stops evaporating completely.
- D) Decreasing the surface area of the reactants can cause the rate of a reaction to increase.

30) A homogeneous material, which is a mixture, is classified as

- \*A) a solution
- B) a pure substance
- C) an element
- D) a compound

31) Pure substances

- A) have variable composition
- B) have three visible phases
- \*C) have constant physical properties
- D) are heterogeneous

12A.1.

32) Air is classified as a mixture because

- \*A) its composition varies
- B) it becomes warm when compressed
- C) it supports burning
- D) it can be liquefied

34) A material or unknown is added to water and stirred. On filtration a residue remains on the filter paper; further experiments show that the quantity of residue is unaffected by the addition of more water. When the filtrate is evaporated, a solid residue is found in the container.

From this information, it can be concluded that the original material or unknown was a(n)

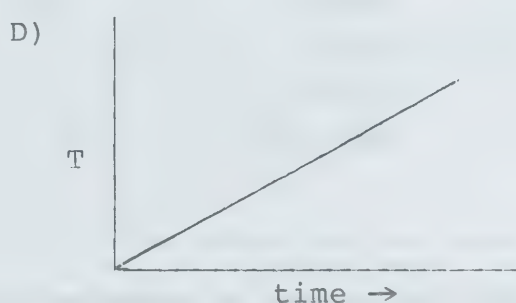
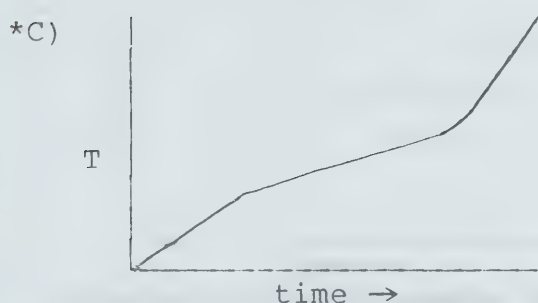
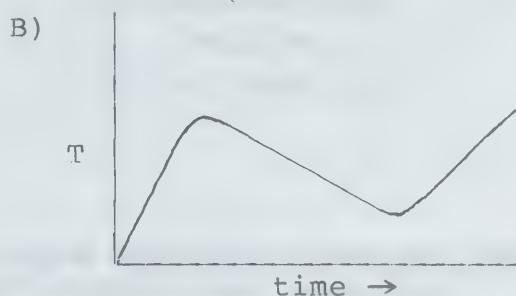
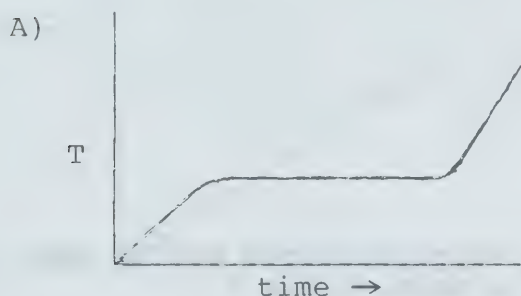
- \*A) mixture
- B) element
- C) pure substance
- D) compound

34) One way in which compounds differ from mixtures is that compounds have

- A) more elements
- B) greater activity
- C) lesser activity
- \*D) definite composition

12A.1.

35) Which of the following diagrams best represents the temperature-time graph for the slow and uniform heating of a mixture through a change of state?



36) An element can be identified most accurately by its

- \*A) density and conductivity
- B) mass and colour
- C) volume and odour
- D) colour and conductivity

37) An Ontario sample of the compound sodium chloride ( $\text{NaCl}$ ) is found to consist of 39.3% sodium, by mass and 60.7% chlorine, by mass. A sample of pure sodium chloride found in the southern United States consists of

- A) 19.7% sodium and 80.3% chlorine
- \*B) 39.3% sodium and 60.7% chlorine
- C) 69.7% sodium and 30.3% chlorine
- D) 79.6% sodium and 20.4% chlorine

12A.1.

38) Sea water is made salt-free by

- A) filtration
- B) chlorination
- C) boiling
- \*D) distillation

39) How many different sugar - water mixtures can be made such that each mixture has a mass of 5 g ?

- A) 1
- B) 5
- C) 25
- \*D) >25

40) The amount of mass per unit volume of a substance is referred to as its

- \*A) density
- B) solubility
- C) malleability
- D) state

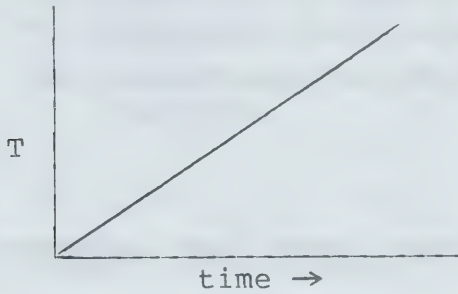
41) The melting point of a pure substance is

- \*A) the same as the freezing point
- B) lower than the freezing point
- C) higher than the freezing point
- D) not related to the freezing point

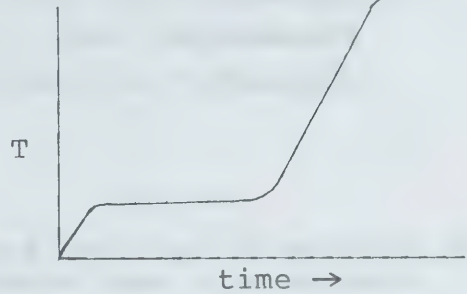
12A.1.

42) Which of the following diagrams best illustrates the temperature-time graph for the heating of ice at  $-10^{\circ}\text{C}$  to produce steam at  $125^{\circ}\text{C}$ ?

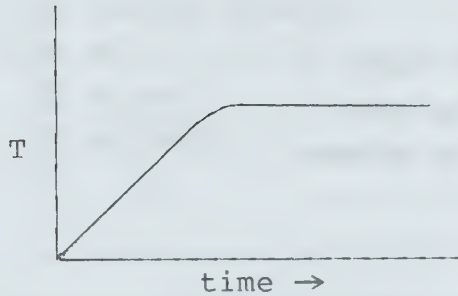
A)



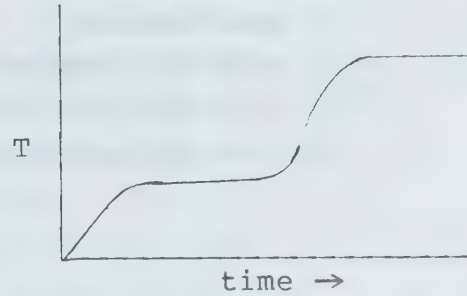
\*B)



C)



D)



12A.1

- 43) Which of the following is an example of an element?
- A) air
  - B) milk
  - \*C) mercury
  - D) salt
- 44) The Law of Definite Proportions states that elements always combine with each other
- A) spontaneously
  - B) with the evolution of heat
  - \*C) in a definite ratio by mass
  - D) in a definite ratio by volume
- 45) Which one of the following statements is true?
- A) An element cannot be a liquid.
  - B) All pure substances are elements.
  - C) The smallest possible particle of any element is a molecule.
  - \*D) All compounds consist of two or more elements.
- 46) In all chemical reactions involving elements, the
- A) volume of the reactants equals the volume of the products
  - \*B) mass of the reactants equals the mass of the products
  - C) masses of the combining elements are equal
  - D) volumes of the combining elements are equal

12A.1.

47) In all chemical reactions the mass of the

- A) products is greater than the mass of reactants
- B) reactants is greater than the mass of products
- \*C) reactants always equals the mass of products
- D) products may be more or less than the mass of reactants

48) An example of an element is

- A) carbon dioxide
- B) air
- C) brass
- \*D) sulphur

49) An example of a compound is

- A) oxygen
- B) mercury
- \*C) salt
- D) diamond

50) When elements combine chemically the

- A) products have properties resembling those of one reactant
- B) products have properties resembling those of all the reactants
- C) properties of the products are the sum of the properties of the reactants
- \*D) properties of the products are generally different from the properties of the reactants

12A.1.

51) A substance is considered to be homogeneous if

- A) every particle is the same size as every other particle
- B) the substance is composed of particles which are different in properties
- C) all particles in the substance are soluble in water
- \*D) every portion of the substance has the same properties as every other portion

52) According to the scientist's method of classification, all samples of matter must be

- A) solids or liquids
- B) elements, compounds or gases
- C) pure substances or compounds
- \*D) elements, compounds or mixtures

53) Which of the following statements is true?

- A) the composition of a heterogeneous mixture is constant
- B) the composition of a homogeneous mixture is constant
- \*C) if 1 g of X combines with 5 g of Y, then 1 kg of X combines with 5 kg of Y
- D) if 1.00 g of X combines with 5.00 g of Y, then 5.00 g of X will combine with 1.00 g of Y

54) A substance composed of two or more elements chemically united is called

- A) a solution
- \*B) a compound
- C) a pure substance
- D) a mixture

12A.1.

55) Carbon is classed as an element rather than as a compound because it

- \*A) cannot be chemically decomposed into two or more substances
- B) has been known for many centuries
- C) is formed when wood is heated out of contact with air
- D) combines with oxygen to form a gas

56) A physical change in a substance

- \*A) changes only the state of the substance
- B) changes it into a different substance
- C) could be a synthesis reaction
- D) causes a change in mass of the substance

57) An example of a chemical change is

- A) the crushing of stones
- B) the formation of clouds
- C) the separation of cream from milk
- \*D) the lighting of a cigarette

58) In a chemical change, the mass of the reacting substances compared to the mass of the products formed is

- A) never the same
- \*B) always the same
- C) less
- D) greater

12A.1.

59) An example of a chemical change is the

- A) condensation of steam
- \*B) corrosion of metals
- C) melting of solder
- D) freezing of water

60) An example of a physical change is

- A) toasting a piece of bread
- B) burning dead leaves
- \*C) boiling alcohol
- D) rusting iron

61) An example of a physical change is

- A) burning
- B) decaying
- \*C) melting
- D) rusting

62) Which one of the following is an example of a physical change?

- \*A) freezing water
- B) burning dead leaves
- C) digesting a piece of bread
- D) rusting iron

63) An example of a physical change is the

- \*A) distillation of petroleum
- B) decomposition of silver nitrate
- C) electrolysis of water
- D) burning of magnesium

12A.1.

64) There is no doubt that a chemical change has occurred if

- \*A) a new substance is formed
- B) there is a change of state
- C) heat is given off
- D) there is an overall volume change

65) In a chemical change, the total mass of the product(s) is

- \*A) the same as that of the reactants
- B) more than that of the reactants
- C) less than that of the reactants
- D) a function of the rate of reaction

66) You have examined a material and all BUT one of the following indicate that it is a pure substance. Which is the factor that shows it must be a mixture?

- A) it is a uniform white powder
- B) it is completely soluble in water
- C) it looks like salt
- \*D) it melts between 245 and 300°C

67) Consider the following statements:

- I George is 30 kg heavier than Frank
- II Hydrogen gas is less dense than air
- III There is a region of low pressure approaching Bradford
- IV Only half the seats in the cafetorium are full
- V The substance consists of coarse irregular lumps

Which of the statements above are qualitative statements?

- A) I and IV
- B) III and V
- C) II, III, IV and V
- \*D) II, III and V

12A.1.

- 68) A mixture consists of two or more components in
- A) definite proportions
  - B) equal proportions
  - \*C) any proportions
  - D) constant proportions
- 69) Which of the following is the most accurate statement?
- A) Matter has mass but no volume.
  - \*B) Matter has mass but not necessarily fixed shape.
  - C) Matter is always solid.
  - D) Matter has neither mass nor volume.
- 70) A homogeneous material of variable composition is
- A) a pure substance
  - B) an element
  - \*C) a solution
  - D) a compound
- 71) Which of the following common substances is a mixture?
- \*A) air
  - B) water
  - C) sugar
  - D) salt
- 72) A pure substance that contains more than one type of atom is called
- A) a solution
  - \*B) a compound
  - C) an element
  - D) an allotrope

12A.1.

73) Which of the following is a chemical property of sulphur?  
It is

- A) solid
- \*B) combustible
- C) odourless
- D) yellow

74) The Law of Definite Composition states that elements always combine with each other

- A) spontaneously
- B) with the evolution of heat
- \*C) in a constant ratio by mass
- D) in a constant ratio by volume

75) A homogeneous mixture is known as

- A) a compound
- B) a pure substance
- C) an element
- \*D) a solution

76) All chemical reactions result in

- A) a change in the structure of the reactant atoms
- B) energy being liberated in the form of heat and/or light
- C) a change in the atomic number of atoms involved
- \*D) a rearrangement of the atoms into new substances

12A.1.

77) A physical change never involves

- \*A) the formation of a new pure substance
- B) a change in colour
- C) a change in density
- D) a change of state

78) A sample of a substance was heated strongly in a crucible and the sample increased in mass. This is evidence that

- A) a gas had been evolved
- B) the substance had melted
- C) the substance had sublimed
- \*D) a chemical change had taken place

79) The reaction in which mercury is formed by heating its oxide is known as a

- A) reverse reaction
- B) synthesis
- \*C) decomposition
- D) double decomposition

80) One example of a chemical change is

- A) heating water
- B) grinding rock
- C) breaking glass
- \*D) baking a cake

81) An example of a simple decomposition reaction is

- A)  $\text{Zn(s)} + \text{CuSO}_4\text{(aq)} \rightarrow \text{ZnSO}_4\text{(aq)} + \text{Cu(s)}$
- \*B)  $(\text{NH}_4)_2\text{CO}_3\text{(s)} \rightarrow 2\text{NH}_3\text{(g)} + \text{H}_2\text{O(g)} + \text{CO}_2\text{(g)}$
- C)  $\text{Ca(s)} + 2\text{H}_2\text{O(l)} \rightarrow \text{Ca(OH)}_2\text{(aq)} + \text{H}_2\text{(g)}$
- D)  $\text{NaCl(aq)} + \text{AgNO}_3\text{(aq)} \rightarrow \text{NaNO}_3\text{(aq)} + \text{AgCl(s)}$

12A.2.

- 1) The symbol for platinum is
  - A) P
  - B) Pl
  - C) Pn
  - \*D) Pt
  
- 2) If water is subdivided or vaporized, the smallest particle able to exist chemically and still retain the original composition is called a(n)
  - A) atom
  - B) electron
  - \*C) molecule
  - D) ion
  
- 3) The positively charged particles in the nucleus of an atom are called
  - \*A) protons
  - B) neutrons
  - C) electrons
  - D) ions
  
- 4) The charged particles that are found outside the nucleus of an atom are called
  - A) protons
  - B) ions
  - \*C) electrons
  - D) mesons

12A.2.

5) The smallest particle of matter which can react chemically is called a(n)

- A) electron
- B) neutron
- C) molecule
- \*D) atom

6) A particle containing 5 protons, 4 electrons and 6 neutrons has approximately the same mass as

- A) 5 protons
- B) 10 protons
- \*C) 11 neutrons
- D) 15 neutrons

7) The positively charged particles in the nucleus of an atom are called

- \*A) protons
- B) neutrons
- C) electrons
- D) isotopes

8) The positively charged particles in the nucleus of an atom are called

- \*A) protons
- B) neutrons
- C) electrons
- D) ions

12A.2.

- 9) Which of the following subatomic particles has the smallest mass?
- \*A) electron
  - B) neutron
  - C) nucleus
  - D) proton
- 10) During an experiment, some of the particles emitted by a radioactive substance were attracted towards a negatively charged plate. These particles were probably
- A) gamma rays
  - B) electrons
  - \*C) helium nuclei
  - D) neutrons
- 11) The nuclear atom was first postulated by
- \*A) Rutherford
  - B) Bohr
  - C) Chadwick
  - D) Dalton
- 12) Which of the following symbols represents an atom that contains the largest number of neutrons?
- A)  $^{235}_{92}\text{U}$
  - \*B)  $^{239}_{92}\text{U}$
  - C)  $^{239}_{93}\text{Np}$
  - D)  $^{239}_{94}\text{Pu}$

12A.2.

13) The nuclide symbol  $^{16}_8\text{O}$  represents an oxygen atom

- A) with a mass of 8 u
- \*B) with a mass of 16 u
- C) with an atomic number of 16
- D) with 16 neutrons

14) The number of electrons in a neutral atom is the same as the atom's

- A) mass number
- B) valence
- C) number of neutrons
- \*D) atomic number

15) If Z represents the atomic number of an element and A represents its mass number, then the number of neutrons in one atom of the element is

- A) A
- B) A + Z
- \*C) A - Z
- D) Z - A

16) Which of the following statements about the elemental species  $^{24}_{11}\text{X}$  and  $^{25}_{12}\text{Z}$  is correct?

- A) They are isotopes of the same element.
- B) They are non-metals.
- C) They are members of the same chemical family.
- \*D) They have the same number of neutrons per atom.

12A.2.

17) The symbol  ${}^{24}_{12}\text{Mg}$  represents a magnesium atom with

- A) 24 neutrons
- B) a mass number of 12
- \*C) a mass number of 24
- D) 12 valence electrons

18) The number of neutrons in one atom of an element is

- A) the same in each isotope
- B) the same as the atomic number
- C) equal to the number of protons in the nucleus
- \*D) equal to the mass number minus the atomic number

19) The number of neutrons in the nucleus of an atom of the element with atomic number 79 and mass number 196 is

- A) 79
- \*B) 117
- C) 196
- D) 275

20) In a neutral atom, the number of protons is equal to the

- A) mass number
- B) number of neutrons
- \*C) number of electrons
- D) number of neutrons minus the number of electrons

21) The atomic mass unit is defined as

- A) the mass of a carbon atom
- \*B) 1/12 of the mass of the carbon atom
- C) 12 g
- D) one microgram

12A.2.

22) The number of protons in an atom of an element is equal to the

- A) difference between the atomic mass and the atomic number
- B) number of neutrons in the nucleus
- \*C) number of electrons surrounding the nucleus
- D) atomic mass of an element

23) An element X has a mass number of 32 and an atomic number of 16. The most common ion of element X is represented by

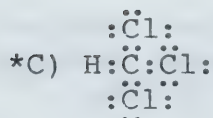
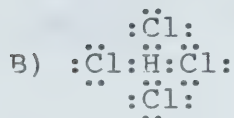
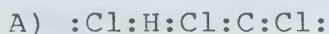
- A)  $X^+$
- \*B)  $X^{2-}$
- C)  $X^-$
- D)  $X^{2+}$

24) The atomic mass of an element is determined primarily by the

- A) number of protons in its nucleus
- B) number of neutrons in its nucleus
- \*C) sum of protons and neutrons in its nucleus
- D) sum of protons and electrons in its nucleus

12A.2.

25) Which one of the following Lewis dot diagrams represents a molecule with the most stable electron configuration?



26) An atom of magnesium,  ${}^{24}_{12}\text{Mg}$ , consists of

A) 24 protons, 24 electrons, 12 neutrons

B) 24 protons, 12 electrons, 24 neutrons

\*C) 12 protons, 12 electrons, 12 neutrons

D) 12 protons, 12 electrons, 24 neutrons

27) The maximum number of electrons possible in the second energy level of an atom is

\*A) 8

B) 2

C) 10

D) 18

12A.2.

28) The maximum numbers of electrons in the K, L, M and N shells of any element are respectively

- \*A) 2, 8, 18, 32
- B) 1, 2, 8, 16
- C) 2, 8, 16, 24
- D) 1, 4, 9, 16

29) The colours of the spectral emission lines produced by the gas in a discharge tube are determined by the

- A) temperature of the gas
- \*B) gas used in the tube
- C) pressure of the gas
- D) applied voltage

30) An electron orbital is best described as

- A) a cloud with hundreds of electrons in it
- B) the figure formed by the extremely rapid motion of electrons
- \*C) a probability function
- D) a cloud which is always perfectly circular

31) How many electrons are usually left out of the electron dot diagrams of the elements with atomic numbers 11 to 18?

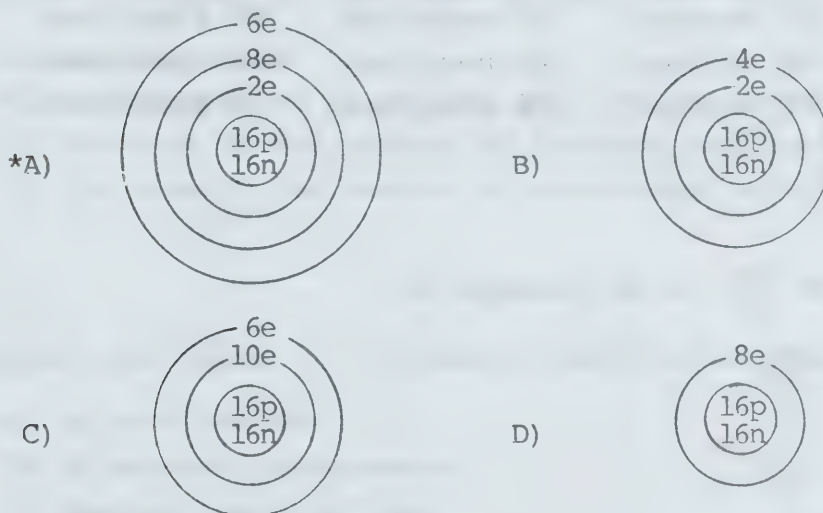
- A) 8
- B) 2
- \*C) 10
- D) 12

12A.2.

32) The electronic configuration of a neutral carbon atom is

- A) 2, 2, 4
- \*B) 2, 4
- C) 1, 5
- D) 2, 6

33) The best energy shell (Bohr) representation for a neutral atom of sulphur,  $^{32}_{16}\text{S}$ , is



34) Relative atomic masses are

- A) fixed in comparison to oxygen
- \*B) weighted averages of isotopic masses
- C) always expressed in whole numbers
- D) averages of allotropic masses

12A.2.

35) The standard for atomic masses is

- \*A) the atom of the most common isotope of carbon
- B) standard temperature and pressure
- C) a kilogram of platinum
- D) hydrogen - the lightest element in the periodic table

36) One atom of the isotope U-238 contains

- A) 92 protons      238 neutrons      92 electrons
- B) 92 protons      92 neutrons      92 electrons
- C) 92 protons      146 neutrons      146 electrons
- \*D) 92 protons      146 neutrons      92 electrons

37) The atom  ${}_{15}^{30}\text{X}$  is an isotope of

- \*A)  ${}_{15}^{27}\text{P}$
- B)  ${}_{16}^{27}\text{S}$
- C)  ${}_{14}^{30}\text{Si}$
- D)  ${}_{30}^{45}\text{Zn}$

38) Isotopes of an element have different numbers of

- A) protons
- \*B) neutrons
- C) electrons
- D) electron, protons and neutrons

12A.2.

- 39) An element has two isotopes of relative atomic masses 41.0 and 44.0. The relative abundance of the isotopes are 90.0% and 10.0% respectively. The relative atomic mass of the element is
- A) 41.0
  - \*B) 41.3
  - C) 42.5
  - D) 43.7
- 40) Atoms of isotopes of the same element are identical in
- A) nuclear mass
  - \*B) the number of electrons outside the nucleus
  - C) the sum of the number of protons and neutrons
  - D) the sum of the number of electrons and neutrons
- 41) Isotopes are forms of the same element which have different
- A) atomic numbers
  - B) electron arrangements
  - C) numbers of electrons
  - \*D) numbers of neutrons
- 42) The new element, Canadium, has two isotopes  $^{300}\text{Cn}$  and  $^{310}\text{Cn}$  with relative abundances of 75% and 25% respectively. The relative atomic mass of Canadium is
- \*A) 302.5
  - B) 305.0
  - C) 307.5
  - D) 309.0

12A.2.

43) Chlorine has two isotopes, Cl-35 and Cl-37. The difference in the composition of these two atoms is

- A) 2 protons
- B) 2 electrons
- \*C) 2 neutrons
- D) 2 alpha particles

44) The symbol,  $^{65}_{30}\text{Zn}$ , indicates that this isotope contains

- \*A) 30 protons and 35 neutrons
- B) 35 protons and 30 neutrons
- C) 65 protons and 30 neutrons
- D) 30 protons and 65 neutrons

45) Boron has two naturally occurring isotopes,  $^{10}_5\text{B}$  and  $^{11}_5\text{B}$ .

The composition of boron is 20%  $^{10}_5\text{B}$  and 80%  $^{11}_5\text{B}$ , by

mass. The relative atomic mass of boron is

- A) 10.2
- B) 10.4
- C) 10.6
- \*D) 10.8

46) Chlorine consists of 25.0%  $^{37}_{17}\text{Cl}$  and 75.0%  $^{35}_{17}\text{Cl}$ . The average atomic mass of chlorine is

- \*A) 35.5
- B) 35.4
- C) 35.0
- D) 17.3

12A.2.

47) Boron has two common isotopes:  $^{10}_5\text{B}$  and  $^{11}_5\text{B}$ . The relative atomic mass of boron is 10.8. The percent  $^{10}_5\text{B}$  in an average sample of boron is

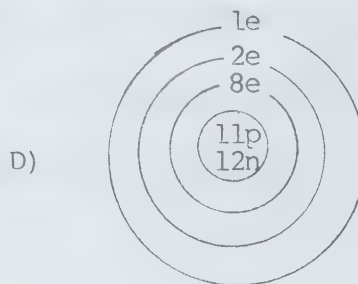
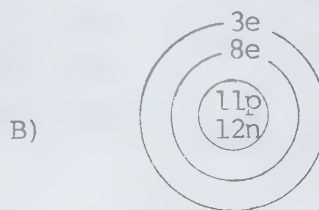
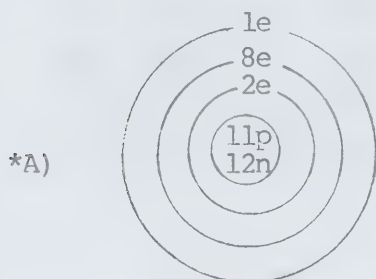
- A) 20%
- \*B) 40%
- C) 50%
- D) 80%

12A.2.

48) Atoms of Be will most likely tend to react with atoms of the element having atomic number

- A) 12
- \*B) 17
- C) 10
- D) 14

49) The best energy shell representation (Bohr diagram) for a neutral atom sodium ( $^{23}_{11}\text{Na}$ ) is



50) The least stable ion in the following list is

- A)  $\text{Mg}^{2+}$
- B)  $\text{Be}^{2+}$
- C)  $\text{O}^{2-}$
- \*D)  $\text{Br}^{+}$

12A.2.

51) Ions are always

- \*A) electrically charged
- B) found in any gas
- C) the same as a crystal
- D) electrically neutral

52) A non-metallic atom generally becomes a negative ion by

- A) losing protons
- B) losing electrons
- C) gaining protons
- \*D) gaining electrons

53) The group of particles having the same number of electrons in each particle is

- A) He  $\text{Li}^+$  Be
- \*B) Ne  $\text{Na}^+$   $\text{Mg}^{2+}$
- C) Ar  $\text{Cl}^-$  S
- D) Ar  $\text{K}^+$   $\text{O}^{2-}$

54) An atom becomes a negatively charged ion when it

- A) loses neutrons
- \*B) gains electrons
- C) gains protons
- D) loses electrons

55) An atom becomes an ion with a charge of plus three when it

- A) loses 3 neutrons
- B) gains 3 protons
- C) gains 3 electrons
- \*D) loses 3 electrons

12A.2.

56) An ion with 12 protons, 10 neutrons, and 11 electrons has a charge of

- \*A) 1+
- B) 2+
- C) 1-
- D) 2-

57) A chlorine atom may become a chloride ion, in a chemical reaction, by

- A) gaining one proton
- B) losing one proton
- \*C) gaining one electron
- D) losing one electron

58) A hydrogen ion with a single positive charge is composed of

- A) one electron and one neutron
- \*B) one proton
- C) one proton and one electron
- D) one neutron

59) The elements Sodium (Na), Neon (Ne), Magnesium (Mg) and Sulphur (S) listed in order of increasing first ionization energy are

- A) Na    Ne    Mg    S
- B) Ne    Mg    Na    S
- \*C) Na    Mg    S    Ne
- D) Ne    S    Mg    Na

12A.2.

60) For the two equations below



- \*A) The energy term in I is the ionization energy and the energy term in II is the electron affinity.
- B) The energy term in I is the electron affinity and the energy term in II is the ionization energy.
- C) The energy terms in I and II both represent ionization energies.
- D) The energy terms in I and II both represent electronegativity.

61) To become a sulphide ion ( $\text{S}^{2-}$ ) a sulphur atom,  $^{32}_{16}\text{S}$ , must

- A) gain 1 electron
- B) lose 1 electron
- \*C) gain 2 electrons
- D) lose 2 electrons

62) Two particles have the following compositions, respectively:

- I) 10 protons, 11 neutrons, 9 electrons
- II) 11 protons, 11 neutrons, 10 electrons

Both of the particles are best described as

- A) isobars
- B) isotopes
- C) inert gases
- \*D) positive ions

12A.2.

- 63) An element X has six electrons in its highest energy level. The element X will probably
- A) form positive ions
  - B) be inert
  - \*C) form negative ions
  - D) be relatively unreactive
- 64) The greater the electropositivity of an element, the greater the tendency of the element to
- A) gain electrons
  - \*B) lose electrons
  - C) gain protons
  - D) lose protons
- 65) An atom of a non-metallic element most commonly becomes an ion, during chemical reaction, by
- A) losing electrons
  - \*B) gaining electrons
  - C) losing protons
  - D) gaining neutrons
- 66) Electron affinity is a measure of the tendency of an element to
- \*A) gain electrons
  - B) gain protons
  - C) lose electrons
  - D) lose protons

12A.2.

67) The elements Fluorine (F), Oxygen (O) and Nitrogen (N) listed in order of increasing electronegativity are

- A) Oxygen      Nitrogen      Fluorine
- B) Fluorine      Nitrogen      Oxygen
- C) Fluorine      Oxygen      Nitrogen
- \*D) Nitrogen      Oxygen      Fluorine

68) When an aluminum atom forms an  $\text{Al}^{3+}$  ion, the atom

- \*A) loses three electrons
- B) gains three electrons
- C) loses three protons
- D) gains three protons

69) The ground state electronic configuration for an atom of neon,  ${}_{10}^{20}\text{Ne}$ , is

- \*A)  $1s^2$      $2s^2$      $2p^6$
- B)  $1s^2$      $2s^2$
- C)  $1s^2$      $2s^2$      $2p^6$      $3s^1$
- D)  $1s^2$      $2s^2$      $2p^6$      $3s^2$      $3p^6$

70) The charged particles located outside the nucleus of an atom are called

- A) protons
- \*B) electrons
- C) isotopes
- D) neutrons

12A.2.

71) An ion is

- A) the same as a crystal
- \*B) electrically charged
- C) electrically neutral
- D) a part of a gas

72) In every negative ion the number of electrons is

- A) less than the number of neutrons
- B) equal to the number of neutrons
- \*C) greater than the number of protons
- D) equal to the number of protons

73) An atom with atomic number 18 and mass number 37 would contain

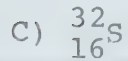
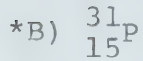
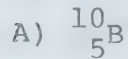
- \*A) 19 neutrons
- B) 37 protons
- C) 19 electrons
- D) 37 neutrons

74) Subtracting the atomic number from the mass number of an atom gives the number of

- A) electrons
- \*B) neutrons
- C) protons
- D) energy levels

12A.2.

75)  $\cdot\dot{\text{N}}\cdot$  is the electron dot symbol for nitrogen. The element that would be represented by an identical electron dot arrangement is



76) The ratio of charge to mass (e/m) of electrons is

- \*A) the same for all elements
- B) different for all elements
- C) a function of the atomic number
- D) a function of the relative atomic mass

77) Which one of the following will be formed from a single hydrogen atom if one electron is removed from it?

- A) an alpha particle
- B) a beta particle
- \*C) a proton
- D) a neutron

78) If the standard for relative atomic masses were chosen as exactly 48 for the oxygen atom (O), the relative atomic mass of hydrogen (H) would be

- A) 1.0
- B) 2.0
- \*C) 3.0
- D) 4.0

12A.2.

79) The diameter of a small atom is closest to

- \*A)  $10^{-10}$  m
- B)  $10^{-9}$  m
- C)  $10^{-8}$  m
- D)  $10^{-7}$  m

80) "The atom consists of a nucleus containing subatomic particles and electrons arranged in concentric shells around the nucleus." This description most clearly fits the atomic theory proposed by

- A) Dalton
- B) Thomson
- \*C) Bohr
- D) Einstein

81) The atomic number of an element is defined as the number of

- A) neutrons in the nucleus
- \*B) protons in the nucleus
- C) electrons in the nucleus
- D) protons and neutrons in the nucleus

82) A neutral atom of the isotope chlorine-37 has 7 electrons in its third energy level. One atom of chlorine-37 must contain

- A) 7 neutrons
- B) 17 neutrons
- C) 18 neutrons
- \*D) 20 neutrons

12A.2.

83) Which one of the following particles has the same number of electrons as an atom of argon,  ${}^{40}_{18}\text{Ar}$ ?

- A)  $\text{S}^{2+}$
- B)  $\text{Mg}^{2+}$
- C)  $\text{K}^{-}$
- \*D)  $\text{P}^{3-}$

84) How many valence electrons are there in one atom of sulphur,  ${}^{32}_{16}\text{S}$ ?

- \*A) 6
- B) 2
- C) 8
- D) 4

85) Three isotopes of hydrogen are known. The atoms of these isotopes

- A) have the same atomic mass
- \*B) have the same atomic number
- C) differ in the number of electrons
- D) differ in the number of protons

86) One atom of the element represented by  ${}^{16}_8\text{O}$  has

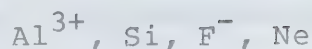
- \*A) 8 protons    8 neutrons    8 electrons
- B) 16 protons    16 neutrons    16 electrons
- C) 16 protons    16 neutrons    8 electrons
- D) 8 protons    8 neutrons    16 electrons

12A.2.

87) The chlorine atom,  ${}^{35}_{17}\text{Cl}$ , has the same number of neutrons as

- A)  ${}^{37}_{17}\text{Cl}$
- B)  ${}^{35}_{16}\text{S}$
- \*C)  ${}^{36}_{18}\text{Ar}$
- D)  ${}^{40}_{20}\text{Ca}$

88) Consider the species



The species that is NOT isoelectronic with the other three is

- A)  $\text{Al}^{3+}$
- \*B) Si
- C)  $\text{F}^{-}$
- D) Ne

89) An element X has three occupied energy levels containing 2, 8 and 2 electrons respectively. The most stable ion formed by this element would be

- A)  $\text{X}^{2-}$
- \*B)  $\text{X}^{2+}$
- C)  $\text{X}^{4-}$
- D)  $\text{X}^{4+}$

90) The elements sodium, (Na), potassium, (K), and lithium, (Li), listed in order of increasing electropositivity are

- A) sodium            potassium            lithium
- B) potassium        sodium                lithium
- C) lithium           potassium                sodium
- \*D) lithium         sodium                 potassium

12A.2.

91) Isotopes of the same element have different numbers of

- \*A) neutrons
- B) electrons
- C) orbitals
- D) protons

92) The element boron has 2 naturally-occurring isotopes,  $^{10}_4\text{B}$  and  $^{11}_4\text{B}$ . If a sample of naturally-occurring boron contains 20% by mass of  $^{10}_4\text{B}$ , the relative atomic mass of the sample would be

- A) 4.2
- B) 8.8
- C) 10.2
- \*D) 10.8

93) How many protons, neutrons, and electrons are there in one potassium ion,  $^{39}_{19}\text{K}^+$  ?

- A) 39 protons, 39 neutrons, 39 electrons
- \*B) 19 protons, 20 neutrons, 18 electrons
- C) 19 protons, 20 neutrons, 20 electrons
- D) 20 protons, 19 neutrons, 19 electrons

94) Isotopes of an element have the same

- A) mass numbers but different atomic numbers
- B) numbers of electrons but different numbers of protons
- C) numbers of protons and neutrons but different numbers of electrons
- \*D) numbers of protons but different mass numbers

12A.2.

95) The number of neutrons in the nucleus of an atom of  ${}^9_4\text{Be}$  is

- \*A) 5
- B) 9
- C) 13
- D) 4

96) Copper exists in nature as two isotopes (mass number 63 and 65) with relative abundances of 70% and 30% respectively. The relative atomic mass of copper is

- A) 63.0
- B) 63.4
- \*C) 63.6
- D) 64.0

97) Which of the following statements about isotopes of the same element is true?

- A) All isotopes of the same element have the same number of neutrons
- \*B) All isotopes of the same element have the same number of protons
- C) Neutral atoms of isotopes of the same element have different numbers of electrons
- D) Atoms of different isotopes of the same element have the same mass

98) One neutral atom of  ${}^{200}_{82}\text{Pb}$  contains

- A) 82 neutrons and 200 protons
- B) 82 protons and 118 electrons
- \*C) 82 electrons and 118 neutrons
- D) 82 protons and 200 neutrons

12A.2.

- 99) Naturally occurring gallium is 60%  $^{69}_{31}\text{Ga}$  and 40%  $^{71}_{31}\text{Ga}$  by mass. The relative atomic mass of this element is
- A) 31.0
  - B) 39.0
  - \*C) 69.8
  - D) 70.0
- 100) The relative atomic mass of an element is
- A) numerically the same as the atomic number
  - B) the total number of protons and neutrons
  - \*C) the weighted average mass of the isotopes
  - D) always a whole number
- 101) The nucleus of the isotope  $^{116}_{50}\text{Sn}$  contains
- A) 116 protons
  - \*B) 50 protons
  - C) 66 electrons
  - D) a total of 166 protons and neutrons
- 102) Atoms with the same atomic number but different atomic mass are called
- A) isomers
  - B) isosceles
  - \*C) isotopes
  - D) isobars

12A.2.

103) The universally accepted standard for atomic and molecular masses is

- \*A) 1/12 of the mass of the most common isotope of carbon
- B) 1/16 of the mass of the most common isotope of oxygen
- C) the mass of the most common isotope of hydrogen
- D) the mass of a standard at the National Bureau of Standards

104) The nucleus of a tritium atom,  ${}^3_1\text{H}$ , contains

- \*A) 1 proton and 2 neutrons
- B) 1 proton and 1 neutron
- C) 1 proton and 3 neutrons
- D) 2 protons and 1 neutron

105) Three isotopes of hydrogen are known. Electrically neutral atoms of these isotopes have

- A) the same atomic mass
- \*B) the same atomic number
- C) different numbers of electrons
- D) different numbers of protons

106) Deuterium is an isotope of

- A) diamond
- \*B) hydrogen
- C) helium
- D) oxygen

12A.2.

- 107) The relative atomic mass of an element is the relative
- A) mass of the most abundant isotope
  - B) weighted average mass of the radioisotopes
  - \*C) weighted average mass of the naturally occurring isotopes
  - D) mass of the protons in the nucleus
- 108) The isotope that has atoms possessing eighteen neutrons in its nucleus is
- A)  $^{38}_{18}\text{Ar}$
  - B)  $^{18}_8\text{O}$
  - C)  $^{36}_{16}\text{S}$
  - \*D)  $^{35}_{17}\text{Cl}$
- 109) The mass of one atom of an element compared to the mass of one atom of Carbon-12 is known as
- A) valence
  - B) molecular mass
  - \*C) relative atomic mass
  - D) mass number
- 110) A single atom of the most common isotope of carbon has a mass of
- A) 1.0 u
  - B) 10 u
  - \*C) 12 u
  - D) 16 u

12A.2.

111) An isotope of lithium consists of 3 protons, 4 neutrons, and 3 electrons. Its mass number is

- A) 6
- \*B) 7
- C) 3
- D) 10

112) The relative atomic mass of chlorine is 35.5. Which one of the following statements is true?

- A) The two isotopes of chlorine have different chemical properties
- B) The abundance of  $^{37}_{17}\text{Cl}$  is approximately three times that of isotopes  $^{35}_{17}\text{Cl}$
- \*C) The abundance of  $^{35}_{17}\text{Cl}$  is approximately three times that of isotopes  $^{37}_{17}\text{Cl}$
- D) Each chlorine atom contains 17 protons, 17 electrons and 18.5 neutrons

113) Isotopes of an element have the same

- \*A) atomic number
- B) number of neutrons
- C) mass number
- D) number of protons and neutrons

114) Isotopes are best described as atoms of a given element which have different

- \*A) masses due to the different number of neutrons present
- B) chemical properties
- C) masses due to a gain or loss of electrons
- D) atomic numbers

12A.2.

115) Suppose that three isotopes of element X occur in nature as follows:

<u>ISOTOPE</u>	<u>RELATIVE ATOMIC MASS</u>	<u>%</u>
1	110.0	60.0%
2	105.0	30.0%
3	100.0	10.0%

The relative atomic mass of the naturally occurring mixture of element X is

- A) 102.5
- B) 105.0
- \*C) 107.5
- D) 315.0

116) Isotopes of a given element all have identical

- A) mass numbers
- B) atomic masses
- \*C) atomic numbers
- D) nuclear structures

117) Tritium is best represented by

- A)  ${}^2_1\text{H}$
- B)  ${}^1_2\text{H}$
- \*C)  ${}^3_1\text{H}$
- D)  ${}^1_3\text{H}$

12A.2.

118) The mass number of a particular isotope is

- \*A) the number of protons + neutrons in the atom
- B) the number of protons + electrons in the atom
- C) the mass of the particular isotope
- D) the number of neutrons in the nucleus

119) Naturally-occurring element X consists of 40% of mass number 51, 50% of mass number 52, and 10% of mass number 53. The relative atomic mass of element X is

- A) 51.1
- B) 51.3
- C) 51.5
- \*D) 51.7

120) 1 u is defined as

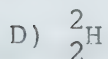
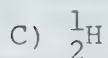
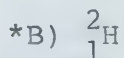
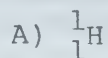
- A) the mass of one hydrogen atom
- B) the mass of one atom of carbon-12
- C)  $\frac{1}{12}$  of the mass of one mole of carbon
- \*D)  $\frac{1}{12}$  of the mass of one atom of carbon-12

121) The nucleus of an isotope of strontium, atomic number 38, mass number 87, contains

- A) 38 protons, 49 electrons
- B) 38 neutrons, 49 protons
- C) 38 electrons, 87 neutrons
- \*D) 38 protons, 49 neutrons

12A.2.

122) Deuterium is best represented by



123) The nucleus of an isotope of tin,  ${}^{116}_{50}\text{Sn}$ , contains

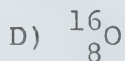
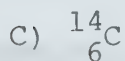
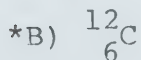
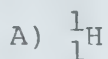
A) 50 neutrons

\*B) 50 protons

C) 66 electrons

D) 66 protons

124) The present international standard of relative atomic masses is based on the mass of an atom of



125) The mass numbers of two naturally occurring isotopes of chlorine are 35 and 37. Which of the following statements is true?

A) Chlorine isotopes have different nuclear charges

B) Cl-35 and Cl-37 have different chemical properties

C) Some naturally occurring chlorine nuclei contain 20 protons

\*D) Some naturally occurring chlorine nuclei contain 20 neutrons

12A.2.

126) The relative atomic mass of an isotope of oxygen is 16. Which of the following statements concerning that isotope are correct?

- I) One atom of this isotope has a mass of 16 u
- II) One atom of this isotope has the same mass as the standard isotope of carbon
- III) One atom of this isotope has a mass  $4/3$  times as much as the standard isotope of carbon
- IV) Oxygen atoms are 8 times as heavy as hydrogen atoms

- A) I and II
- \*B) I and III
- C) I and IV
- D) I only

127) An isotope of a particular element has a mass  $1/6$  that of the atom selected as the standard for atomic mass. The atomic mass of the isotope must be

- A) 1.007 8
- \*B) 2.014 10
- C) 0.166 67
- D) 4.002 60

128) Deuterium,  ${}^2_1\text{D}$ , is chemically related to the element

- A) lithium
- B) helium
- \*C) hydrogen
- D) oxygen

12A.2.

129) One of the isotopes of copper is  ${}^{63}_{29}\text{Cu}$ . The mass of this isotope is

- A) 29 u
- B) 34 u
- \*C) 63 u
- D) 92 u

130) The relative atomic mass of chlorine, 35.453, is a good indication that

- A) chlorine is a compound, not an element
- \*B) chlorine is a mixture of isotopes
- C) chlorine nuclei contain fractions of a neutron
- D) chlorine consists of the molecule  $\text{Cl}_2$

131) The mass number assigned to the isotope of carbon selected as the standard is

- A) 1
- B) 10
- \*C) 12
- D) 16

12A.2.

132) If the mass number of an atom is increased by the addition of neutrons to the nucleus, the result is the formation of a(n)

- A) ion
- \*B) isotope
- C) positively charged atom
- D) different element

133) Consider the sets of charged objects shown in the diagram:



Which of the following statements concerning them is true?

- A) I and III are examples of attractive forces.
- \*B) The largest attractive force is case II.
- C) The largest repulsive force is case III.
- D) The attractive force in II is twice that in IV.

134) Rutherford performed an experiment which provided evidence that atomic nuclei are

- A) positively charged and close together
- B) negatively charged and close together
- \*C) positively charged and far apart
- D) negatively charged and far apart

12A.2.

135) The atomic number of an element refers to

- A) the number of atoms in 1 g of the element
- B) the mass of an atom of the element
- C) the number of atoms in a molecule of the element
- \*D) the number of protons in an atom of the element

136) An atom of the element boron consists of 5 protons, 6 neutrons, and 5 electrons. Its atomic number is

- \*A) 5
- B) 6
- C) 11
- D) 16

137) The electronic configuration for a neutral magnesium atom is

- A) 2,2
- \*B) 2,8,2
- C) 2,8,8,2
- D) 2,8,18,2

138) The elements which have only "s" valence electrons are the

- \*A) alkali metals
- B) rare gases
- C) nitrogen family
- D) halogens

12A.2.

139) If the relative atomic masses of the elements were based on the carbon atom assigned the value of 100, then the relative atomic mass of an oxygen atom would be about

- A) 16
- B) 32
- C) 116
- \*D) 133

140) Potassium ion,  $K^+$ , has the same electronic structure as a neutral atom of

- A) sulphur
- B) xenon
- C) calcium
- \*D) argon

141) Which one of the following ionic equations correctly represents the formation of a magnesium ion from a magnesium atom?

- A)  $Mg + 2e^- \rightarrow Mg^{2+}$
- \*B)  $Mg \rightarrow Mg^{2+} + 2e^-$
- C)  $Mg^{2+} + 2e^- \rightarrow Mg$
- D)  $Mg \rightarrow Mg^{3+} + 1e^-$

142) The correct way to represent a chloride ion is

- A) Cl
- B)  $Cl^0$
- \*C)  $Cl^-$
- D)  $Cl^+$

12A.2.

143) An isotope of silver has 47 protons and 60 neutrons.  
A different isotope of silver could contain

- A) 46 protons and 60 neutrons
- B) 46 protons and 61 neutrons
- \*C) 47 protons and 61 neutrons
- D) 60 protons and 47 neutrons

144) The element, lithium, atomic number three, has the ground state electron configuration

- \*A)  $1s^2 2s^1$
- B)  $1s^2 2s^2$
- C)  $1s^2 2s^2 2p^1$
- D)  $1s^2 2s^2 2p^6 3s^1$

145) The beryllium-9 atom has 4 protons and 5 neutrons in its nucleus, two electrons in its first energy level and two electrons in its second energy level. The atomic number of beryllium is

- A) 9
- B) 2
- C) 7
- \*D) 4

146) The atomic number of the electrically neutral element whose electron configuration is represented by  $1s^2 2s^2 2p^1$  is

- A) 1
- \*B) 5
- C) 3
- D) 4

12A.2.

147) The light from all fluorescent lights, when analyzed in a spectrometer, exhibits the same lines in the yellow, green and blue spectral regions. This is evidence that

- A) fluorescent lights contain fluorine gas
- B) there are no gases present in fluorescent lights
- \*C) the same element is present in all fluorescent lights
- D) air is present in all fluorescent lights

148) In the orbital notation  $1s^2$  the coefficient 1 refers to the fact that

- \*A) the electron is in the first energy level
- B) hydrogen has 1 electron
- C) hydrogen has a relative atomic mass of 1
- D) the subshell is only partially filled

149) The electron configuration of nitrogen is

- \*A) 2, 5
- B) 2, 7
- C) 2, 8, 4
- D) 2, 8, 5

150) The element oxygen, atomic number eight, has a ground state electron configuration represented by

- A)  $1s^2$   $2s^2$   $2p^1$
- B)  $1s^2$   $2s^2$   $2p^2$
- \*C)  $1s^2$   $2s^2$   $2p^4$
- D)  $1s^2$   $2s^2$   $2p^6$

12A.2.

151) The number of protons in a neutral atom of an element is equal to the

- A) atomic mass minus the atomic number
- B) number of neutrons in the nucleus
- \*C) number of electrons surrounding the nucleus
- D) atomic mass of the element

152) A potassium ion,  $K^+$ , has the same electronic structure as

- \*A) a sulfide ion ( $S^{2-}$ )
- B) a xenon atom (Xe)
- C) a calcium atom (Ca)
- D) a fluoride ion ( $F^-$ )

153) The electronic configuration for the neon atom,  ${}^{20}_{10}\text{Ne}$ , is

- \*A)  $1s^2 2s^2 2p^6$
- B)  $1s^2 2s^2 2p^6 3s^1$
- C)  $1s^2 2s^2 2p^6 3s^2$
- D)  $1s^2 2s^2 2p^6 3s^2 3s^6 3d^2$

154) Which of the following electronic configurations is most characteristic of a non-metallic element?

- A)  $1s^2 2s^2 2p^6 3s^1$
- B)  $1s^2 2s^2 2p^6 3p^1$
- C)  $1s^2 2s^2 2p^6 3s^2$
- \*D)  $1s^2 2s^2 2p^6 3s^2 3p^5$

12A.2.

155) The number of electrons in the outermost shell (highest energy level) of a calcium atom (atomic number 20) is

- A) 8
- \*B) 2
- C) 10
- D) 18

156) The ground state electronic configuration for carbon,  ${}^{12}_6\text{C}$ , is

- \*A)  $1s^2$      $2s^2$      $2p^2$
- B) [Ne]     $3s^2$      $3p^6$
- C) [Ne]     $3s^2$      $3p^4$
- D)  $1s^2$      $2s^2$      $2p^1$

157) The maximum number of electrons in the second energy level,  $n = 2$ , of any atom, is

- \*A) 8
- B) 2
- C) 16
- D) 4

158) A noble gas is represented by the electronic configuration

- A)  $1s^2$   $2s^2$   $2p^1$
- \*B)  $1s^2$   $2s^2$   $2p^6$
- C)  $1s^2$   $2s^2$   $2p^6$   $3s^1$
- D)  $1s^2$   $2s^2$   $2p^6$   $3s^2$

12A.2.

159) Which one of the following electron configurations represents the element with the highest first ionization potential?

- A) 2, 5
- \*B) 2, 7
- C) 2, 8, 1
- D) 2, 8, 2

160) The maximum number of electrons that may be accommodated in the 4th energy level of any atom is

- \*A) 32
- B) 16
- C) 8
- D) 4

161) The electronic configuration of the  $S^{2-}$  ion may be represented by

- A)  $1s^2 2s^2 2p^6 3s^2 3p^4$
- B)  $1s^2 2s^2 2p^6 3s^2 3p^2$
- \*C)  $1s^2 2s^2 2p^6 3s^2 3p^6$
- D)  $1s^2 2s^2 2p^6 3s^2 3p^5$

162) The maximum number of electrons which can occupy the 3rd energy level of any atom is

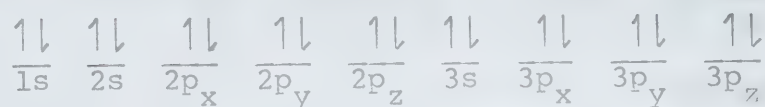
- A) 8
- B) 2
- C) 9
- \*D) 18

12A.2.

163) The atomic number of an element whose electronic configuration is represented by  $1s^2 2s^2 2p^1$  is

- A) 1
- \*B) 5
- C) 3
- D) 4

164) Consider the orbital occupancy diagram



The species that does NOT have this orbital occupancy pattern is

- A)  ${}^{40}_{18}\text{Ar}$
- \*B)  ${}^{34}_{16}\text{S}$
- C)  ${}^{37}_{17}\text{Cl}^-$
- D)  ${}^{39}_{19}\text{K}^+$

165) The Lewis Dot diagram for an atom of sulphur,  ${}^{32}_{16}\text{S}$ , is

- \*A)  $\begin{array}{c} \cdot\cdot \\ \text{S} \\ \cdot\cdot \end{array}$
- B)  $\begin{array}{c} \cdot\cdot \\ :\text{S}: \\ \cdot\cdot \end{array}$
- C)  $\begin{array}{c} \cdot \\ \cdot\text{S}\cdot \\ \cdot \end{array}$
- D)  $\begin{array}{c} \cdot\cdot \\ \cdot\text{S}: \\ \cdot\cdot \end{array}$

12A.2.

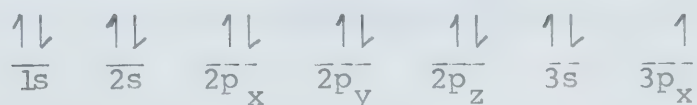
166) The orbital occupancy diagram for an atom of sodium (Na) in its lowest-energy state is

- \*A)  $\begin{array}{cccccc} \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow \\ \overline{1s} & \overline{2s} & \overline{2p_x} & \overline{2p_y} & \overline{2p_z} & \overline{3s} \end{array}$
- B)  $\begin{array}{cccccc} \uparrow\downarrow & \uparrow\downarrow & \uparrow & \uparrow & \uparrow & \uparrow\downarrow & \uparrow\downarrow \\ \overline{1s} & \overline{2s} & \overline{2p_x} & \overline{2p_y} & \overline{2p_z} & \overline{3s} & \overline{3p} \end{array}$
- C)  $\begin{array}{cccccc} \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow \\ \overline{1s} & \overline{2s} & \overline{2p} & \overline{2d} & \overline{3s} & \overline{3p} \end{array}$
- D)  $\begin{array}{cccccc} \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow \\ \overline{1s} & \overline{2s} & \overline{2p} & \overline{3p} & \overline{3s} & \overline{3p} \end{array}$

167) The Lewis dot diagram for a chloride ion ( $\text{Cl}^-$ ) is

- \*A)  $\begin{array}{c} \cdot\cdot \\ :\ddot{\text{Cl}}: \\ \cdot\cdot \end{array}$
- B)  $\begin{array}{c} \cdot\cdot \\ \text{Cl}: \\ \cdot\cdot \end{array}$
- C)  $\begin{array}{c} \cdot\cdot \\ \cdot\ddot{\text{Cl}}: \\ \cdot\cdot \end{array}$
- D)  $\begin{array}{c} \cdot\cdot \\ \cdot\ddot{\text{Cl}}: \\ \cdot\cdot \end{array}$

168) Consider the orbital occupancy diagram



The species that has this orbital occupancy is

- A)  $^{13}_{7}\text{N}$
- \*B)  $^{27}_{13}\text{Al}$
- C)  $^{26}_{13}\text{Al}^{3+}$
- D)  $^{28}_{15}\text{P}^{2-}$

12A.2.

169) An ion is

- A) a radioactive atom
- B) an electrolytic solution
- C) a neutral atom
- \*D) a charged atom

170) An ion is an atom, or a group of atoms, which is

- A) electrically neutral
- \*B) electrically charged
- C) always positive
- D) always negative

171) All positive ions differ from their corresponding neutral atoms because the positive ions have

- A) larger diameters
- B) stronger metallic properties
- C) more electrons
- \*D) fewer electrons

172) An oxygen ion with a charge of  $2-$  has

- A) 6 protons and 10 electrons
- B) 8 protons and 6 electrons
- \*C) 8 protons and 10 electrons
- D) 16 protons and 18 electrons

173) Which one of the following groups of particles has the same number of electrons in each particle?

- A) Ar,  $\text{Cl}^-$ ,  $\text{Br}^-$
- \*B) Ne,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$
- C) S, Ar,  $\text{Cl}^-$
- D) Ne,  $\text{K}^+$ ,  $\text{O}^{2-}$

12A.2.

174) Which one of the following equations represents a reaction which is capable, logically, of taking place



175) An ion of the element Al (aluminum) carries a charge of 3+. Which line in the following table best describes this ion?

	ATOMIC No.	MASS No.	No. OF PROTONS	No. OF NEUTRONS	No. OF ELECTRONS
A)	10	13	13	10	13
B)	13	13	10	14	13
*C)	13	27	13	14	10
D)	13	27	13	14	13

176) If a positively charged ion has 19 protons in its nucleus and a mass number of 39, there are

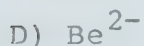
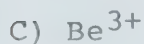
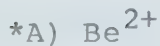
A) 19 neutrons in the nucleus

B) 19 electrons around the nucleus

\*C) fewer than 19 electrons around the nucleus

D) more than 19 electrons around the nucleus

177) Which is the most stable ion of beryllium,  ${}^9_4\text{Be}$ ?



12A.2.

178) A magnesium ion ( $\text{Mg}^{2+}$ ) is a magnesium atom which has

- A) gained two electrons
- \*B) lost two electrons
- C) been reduced
- D) lost one electron

179) When sodium (atomic number 11) becomes an ion,  $\text{Na}^+$ , it

- \*A) loses an electron
- B) gains an electron
- C) changes to neon
- D) becomes larger

180) To become a calcium ion,  $\text{Ca}^{2+}$ , a calcium atom must

- A) gain two electrons
- B) gain two protons
- \*C) lose two electrons
- D) lose two neutrons

181) An atom which loses or gains an electron becomes

- \*A) an ion
- B) a radical
- C) an isotope
- D) a molecule

182) Which one of the following particles has the same number of electrons as the magnesium ion,  $\text{Mg}^{2+}$ ?

- A)  $\text{Ca}^{2+}$
- \*B)  $\text{Na}^+$
- C) F
- D)  $\text{Ne}^+$

12A.2.

183) Ions are usually formed by the transfer of

- A) neutrons
- \*B) electrons
- C) neutrinos
- D) protons

184) The species which has the same number of electrons as  $\text{Mg}^{2+}$  is

- A) Na
- \*B)  $\text{O}^{2-}$
- C)  $\text{N}^-$
- D) Ar

185) When an atom loses one electron, the particle formed is

- \*A) a positive ion
- B) a molecule
- C) a negative ion
- D) an isotope

186) When a bromine atom (Br) becomes an ion ( $\text{Br}^-$ ) in a chemical reaction the

- A) ion has the same diameter as the atom
- B) ion has a smaller diameter than the atom
- \*C) ion has a larger diameter than the atom
- D) nucleus becomes larger

12A.2.

187) Which of the following statements apply when an atom of Cl (chlorine) becomes an ion in a chemical reaction?

- I) Its charge is probably  $1+$
- II) Its charge is probably  $1-$
- III) The ion will be larger than the atom
- IV) The ion will be smaller than the atom

- A) I and III
- B) I and IV
- \*C) II and III
- D) II and IV

188) Consider the electron configurations for elements W, X, Y and Z:

Element	Electron Configuration
W	2,8,7
X	2,8,8
Y	2,8,8,1
Z	2,8,8,2

The element with the lowest first ionization potential (ionization energy) is

- A) W
- B) X
- \*C) Y
- D) Z

12A.2.

- 189) Consider the electron configurations for the elements V, W, X and Y

Element	Electron Configuration
V	2,8,6
W	2,8,7
X	2,8,8
Y	2,8,8,1

The most electronegative element is

- A) V
  - \*B) W
  - C) X
  - D) Y
- 190) Based on the properties of Ca, O, Na, Al and Cl, which one of the following statements is true?
- A) Only Ca and Na are metals.
  - B) Cl is the only non-metal.
  - C) Al is the only metal.
  - \*D) Cl and O are non-metals.
- 191) The elements neon (Ne), sodium (Na), chlorine (Cl) and iodine (I), arranged in order of increasing ionization energy are

- A) Ne    Na    Cl    I
- \*B) Na    I    Cl    Ne
- C) Cl    I    Ne    Na
- D) Na    Cl    I    Ne

- 192) Which of the following particles is most stable?

- A)  $\text{He}^+(\text{g})$
- \*B)  $\text{He}(\text{g})$
- C)  $\text{Ne}^+(\text{g})$
- D)  $\text{Ne}(\text{g})$

12A.2.

193) Which of the following elements requires the least amount of energy to remove an electron from an atom to form an ion?

- A) O
- B) He
- \*C) K
- D) H

194) The graph of first ionization energies of the elements versus atomic number (1 to 20) most closely resembles a(n)

- A) straight line
- B) circle
- \*C) staircase
- D) oval

195) The plot of first ionization energy of the elements versus their atomic numbers most closely supports the

- \*A) Bohr Theory of the Atom
- B) Dalton Theory of the Atom
- C) Rutherford Theory of the Atom
- D) Thompson Theory of the Atom

196) The diameter of a sodium atom (Na) is larger than the diameter of a sodium ion ( $\text{Na}^+$ ) because the

- A)  $\text{Na}^+$  ion contains more protons than the Na atom
- B)  $\text{Na}^+$  ion contains fewer protons than the Na atom
- \*C)  $\text{Na}^+$  ion has a greater p/e ratio than the Na atom
- D)  $\text{Na}^+$  ion has a smaller p/e ratio than the Na atom

12A.2.

197) Consider the equation:



The "energy" term in the equation is an example of

- A) electron affinity
- \*B) ionization energy
- C) sublimation energy
- D) heat of vapourization

198) The greater the electronegativity of an element the greater the tendency of the element to

- \*A) gain electrons
- B) lose electrons
- C) gain protons
- C) lose protons

199) Neutral atoms with a high tendency to attract electrons are said to have a high

- A) electropositivity
- \*B) electron affinity
- C) ionic charge
- D) valence

200) Atoms of element X, having two valence electrons, combine with atoms of the element Y, having seven valence electrons. Which of the following statements is true?

- A)  $X^{2-}$  ions are formed
- B)  $Y^{2-}$  ions are formed
- C) The compound formed has the formula  $X_2Y$
- \*D) The compound formed has the formula  $XY_2$

12A.2.

201) Metallic elements tend to have a high

- A) electronegativity
- \*B) electropositivity
- C) electron affinity
- D) ionization energy

202) Consider the equation:



The energy term in this equation is called the

- A) electron affinity
- B) electronegativity
- \*C) ionization energy
- D) heat of solution

12A.2.

203) The chemical properties of atoms depend primarily upon

- A) the atomic masses of the atoms
- B) the masses of the atoms
- \*C) the numbers of valence electrons
- D) the masses of the nuclei

204) Protons in atoms are

- \*A) heavier than electrons
- B) lighter than electrons
- C) negatively charged
- D) removed when ions form

205) The number of protons in an atom is equal to the

- A) relative atomic mass
- B) mass number
- C) atomic mass plus the atomic number
- \*D) atomic number

206) An ion containing 11 protons, 10 electrons and 12 neutrons has approximately the same mass as

- A) 21 protons
- B) 22 neutrons
- C) 33 neutrons
- \*D) 23 protons

207) The nucleus of an atom

- A) occupies most of the volume of the atom
- B) is not very heavy compared to the whole atom
- \*C) is the densest portion of the atom
- D) is not charged electrically

12A.2.

208) The man who first postulated the concept of the nuclear atom was

- A) Moseley
- \*B) Rutherford
- C) Dalton
- D) Bohr

209) Sir Ernest Rutherford performed an experiment which gave evidence that nuclei of atoms are

- A) relatively far apart and negatively charged
- B) relatively close together and negatively charged
- \*C) relatively far apart and positively charged
- D) relatively close together and positively charged

210) The maximum number of electrons which can occupy the 3rd principal energy level of any atom is

- A) 3
- B) 2
- C) 10
- \*D) 18

211) The mass number of an atom is determined by the number of

- A) protons and electrons
- B) protons
- \*C) protons and neutrons
- D) neutrons

12A.2.

212) The atomic number of an element is 12 and the mass number is 25. One atom of the element consists of

- A) 13 protons, 12 neutrons, 13 electrons
- \*B) 12 protons, 13 neutrons, 12 electrons
- C) 13 protons, 13 neutrons, 13 electrons
- D) 12 protons, 13 neutrons, 13 electrons

213) An atom of the element fluorine ( ${}^{19}_{9}\text{F}$ ) contains

- A) 19 protons, 19 electrons, 9 neutrons
- B) 19 protons, 19 electrons, 10 neutrons
- C) 9 protons, 9 electrons, 19 neutrons
- \*D) 9 protons, 9 electrons, 10 neutrons

214) The atomic number of an element is based on the

- \*A) number of protons in the atom
- B) relative atomic mass of the atom
- C) mass number of the atom
- D) number of neutrons in the atom

215) An isotope of gallium has 31 protons, 38 neutrons and 31 electrons. Another isotope of gallium might contain

- A) 32 protons, 38 neutrons, 32 electrons
- B) 32 protons, 31 neutrons, 31 electrons
- C) 31 protons, 31 neutrons, 39 electrons
- \*D) 31 protons, 39 neutrons, 31 electrons

12A.2.

- 216) An element Q has three isotopes with relative abundances as shown

$$^{14}\text{Q} : 20.0\%$$

$$^{15}\text{Q} : 30.0\%$$

$$^{18}\text{Q} : 50.0\%$$

The relative atomic mass of Q is

- A) 14.8
  - B) 15.7
  - \*C) 16.3
  - D) 18.0
- 217) A neutral atom of the element boron contains 5 protons, 5 electrons and 6 neutrons. Its atomic number is

- \*A) 5
- B) 6
- C) 11
- D) 16

- 218) Isotopes of a given element all have the same

- \*A) atomic number
- B) mass number
- C) relative mass
- D) nuclear structure

- 219) Which of the following sets of atomic symbols represents a group of isotopes of the same element?

- A)  $^{28}_{14}\text{A}$      $^{28}_{15}\text{B}$      $^{28}_{16}\text{C}$
- \*B)  $^1_1\text{X}$      $^2_1\text{Y}$      $^3_1\text{Z}$
- C)  $^{12}_6\text{Q}$      $^{16}_8\text{R}$      $^{20}_{10}\text{S}$
- D)  $^{40}_{20}\text{T}$      $^{39}_{19}\text{U}$      $^{38}_{18}\text{V}$

12A.2.

220) Isotopes of an element have DIFFERENT numbers of

- \*A) neutrons
- B) protons
- C) electrons
- D) electrons, protons, and neutrons

221) The element magnesium consists of the isotopes listed below

<u>Isotope</u>	<u>% Relative Abundance</u>
Mg-24	78.70
Mg-25	10.13
Mg-26	<u>11.17</u>
	100.00

This information enables us to estimate an average atomic mass of

- A) 24.43
- B) 25.00
- C) 24.22
- \*D) 24.32

222) Isotopes of an element differ in

- \*A) mass number
- B) atomic number
- C) number of protons
- D) number of electrons

223) An element consists of atoms all of which have the same number of

- A) neutrons
- \*B) protons
- C) nuclear particles
- D) neutrons plus protons

12A.2.

224) An isotope of lithium consists of 3 protons, 4 neutrons and 3 electrons. The mass number of the lithium isotope is

- A) 6
- \*B) 7
- C) 3
- D) 10

225) An isotope of a particular element has a mass approximately  $\frac{1}{6}$  that of the atom selected as the standard for atomic mass. The atomic mass of the isotope is

- A) 1.0078
- \*B) 2.0141
- C) 0.16667
- D) 72.066

226) An atom of element X has 11 protons and 12 neutrons while an atom of element Y has 12 protons and 12 neutrons. X and Y

- A) are isotopes of the same element
- B) are allotropes of the same element
- C) are isomers of the same compound
- \*D) are metals in the same row of the Periodic Table

227) Subtracting the atomic number from the mass number of a given atom gives the number of

- A) electrons
- \*B) neutrons
- C) protons
- D) energy levels

12A.2.

228) The relative atomic mass of potassium is 39 and its atomic number is 19. The number of protons in a potassium atom is

- \*A) 19
- B) 20
- C) 39
- D) 58

229) The relative atomic mass of an element is most closely related to the number of

- A) valence electrons and protons
- B) protons in the nucleus
- C) neutrons in the nucleus
- \*D) neutrons and protons in the nucleus

230) There are ten stable isotopes of tin. The atoms of these isotopes

- \*A) have the same electronic configuration
- B) have the same mass
- C) have different atomic numbers
- D) have different numbers of protons

231) The element gallium has two stable isotopes,  $^{69}_{31}\text{Ga}$  (60%) and  $^{71}_{31}\text{Ga}$  (40%). The relative proportions, in nature, of the two isotopes are given in the brackets. The relative atomic mass of gallium is approximately

- A) 31.0
- \*B) 69.8
- C) 70.0
- D) 140

12A.2.

232) Isotopes have the same

- A) mass number but different atomic numbers
- B) number of electrons but different numbers of protons
- \*C) number of protons but different mass numbers
- D) number of protons but different atomic numbers

233) The electron configurations of the elements W, X, Y and Z are shown below. Which element is most likely to form a 2- ion ?

- A) W 2, 8, 2
- B) X 2, 8, 1
- C) Y 2, 8, 5
- \*D) Z 2, 8, 6

234) When a metallic element becomes an ion it most commonly

- \*A) loses electrons
- B) gains electrons
- C) loses protons
- D) gains protons

235) An atom of the element "X" has the electron configuration 2, 5. Which of the following would represent the most commonly formed ion of "X"?

- A)  $X^{5+}$
- B)  $X^{5-}$
- C)  $X^{3+}$
- \*D)  $X^{3-}$

12A.2.

236) In which of the following sets do all the atoms and ions have the same number of electrons?

- \*A)  $F^{-}$ , Ne,  $Na^{+}$
- B)  $F^{-}$ ,  $Cl^{-}$ ,  $Br^{-}$
- C) He, Ne, Ar
- D)  $Li^{+}$ ,  $Na^{+}$ ,  $K^{+}$

237) When a neutral atom loses one electron the particle formed is

- \*A) a positive ion
- B) a molecule
- C) a negative ion
- D) an isotope

238) The atom or ion which has the same number of electrons as  $Mg^{2+}$  is

- A) Na
- \*B)  $O^{2-}$
- C)  $N^{-}$
- D) Ar

239) The least reactive of the following elements is

- A) potassium
- B) carbon
- \*C) argon
- D) iron

12A.2.

- 240) Which of the following electron configurations represents the most reactive non-metal?
- A) 2, 8, 1
  - B) 2, 8, 3
  - \*C) 2, 8, 7
  - D) 2, 8, 8
- 241) In a chemical reaction a non-metallic atom usually becomes an ion by
- A) losing protons
  - B) gaining protons
  - C) losing electrons
  - \*D) gaining electrons
- 241) All positive ions differ from their corresponding neutral atoms by having
- \*A) fewer electrons than the neutral atoms
  - B) more electrons than the neutral atoms
  - C) fewer protons than the neutral atoms
  - D) more protons than the neutral atoms
- 243) Which of the following electron configurations represents atoms of the element with highest 2nd ionization energy?
- \*A) 2, 8, 1
  - B) 2, 8, 3
  - C) 2, 8, 7
  - D) 2, 8, 8

12A.2.

244) Which of the following electron configurations represents the least reactive element?

- A) 2, 8, 1
- B) 2, 8, 3
- C) 2, 8, 7
- \*D) 2, 8, 8

245) Which of the following groups of particles has the same number of electrons in each particle?

- A) He, Be,  $\text{Li}^+$
- \*B) Ne,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$
- C) S, Ar,  $\text{Cl}^-$
- D) Ne,  $\text{K}^+$ ,  $\text{O}^{2-}$

246) In a chemical reaction a metallic atom usually

- A) gains protons
- B) loses protons
- \*C) gains electrons
- D) loses electrons

247) The atomic number of an element is 17. When, as the result of a chemical reaction, one atom of this element becomes an ion it will most likely have a charge of

- A) +1
- \*B) -1
- C) +5
- D) -5

12A.2.

248) Which element has the lowest first ionization energy?

- A) fluorine
- B) neon
- \*C) sodium
- D) magnesium

Question 249 refers to the following elements of the the same family. The numbers shown to the left of the symbols are the atomic numbers of the respective elements.

- A     $_{11}\text{Na}$
- B     $_{19}\text{K}$
- C     $_{37}\text{Rb}$
- D     $_{55}\text{Cs}$

249) Which of the elements is most easily ionized?

- A) A
- B) B
- C) C
- \*D) D

Question 250 refers to the following elements of the the same family. The numbers shown to the left of the symbols are the atomic numbers of the respective elements.

- A     $_{11}\text{Na}$
- B     $_{19}\text{K}$
- C     $_{37}\text{Rb}$
- D     $_{55}\text{Cs}$

250) Which of the elements is the least metallic?

- \*A) A
- B) B
- C) C
- D) D

12A.2.

251) When a metallic atom becomes an ion it

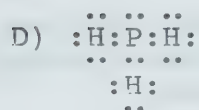
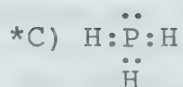
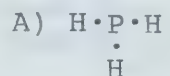
- A) gains protons
- B) becomes larger
- C) gains electrons
- \*D) loses electrons

12A.3.

- 1) Atom M whose electronegativity is 1.0 combines with atom N whose electronegativity is 3.5. Which of the following diagrams best represents the product?
- A) M:N
  - B)  $M^{-} N^{+}$
  - \*C)  $M^{+} N^{-}$
  - D)  $M^{-} N$
- 2) The energy released when a neutral atom gains an electron is called
- A) ionization energy
  - B) bond energy
  - C) nuclear charge
  - \*D) electron affinity
- 3) A covalent bond would be most likely to form between atoms of chlorine and
- A) potassium
  - \*B) phosphorus
  - C) magnesium
  - D) iron

12A.3.

4) The electron dot diagram for  $\text{PH}_3(\text{g})$  is



5) The element in the list below which has two common allotropic forms is

- A) calcium
- \*B) carbon
- C) chromium
- D) copper

12A.3.

6) A chlorine and hydrogen atom unite to form an HCl (hydrogen chloride) molecule. The statement which best describes the attractive and repulsive forces that exist in such a molecule is

- A) The repulsive forces between electrons and between the two nuclei exceed the attractive forces between the nuclei and the electrons.
- \*B) The repulsive forces between electrons and between the two nuclei are in balance with the attractive forces between the nuclei and the electrons.
- C) There are no electron - electron repulsions when a bond is formed.
- D) The attraction between the hydrogen nucleus and the electrons is equal to the attraction between the chlorine nucleus and the electrons.

7) The compound in the following list which is the best example of an ionic solid is

- \*A) calcium bromide ( $\text{CaBr}_2$ )
- B) boron(III) fluoride ( $\text{BF}_3$ )
- C) carbon tetrachloride ( $\text{CCl}_4$ )
- D) silicon(IV) hydride ( $\text{SiH}_4$ )

12A.3.

8) Consider the following information about four substances:

Substance	Melting Point	<u>Electrical Conductivity</u>		Water solubility
		in solid	in liquid	
I	1050	low	high	high
II	75	low	low	low
III	1234	high	high	low
IV	1913	low	low	low

The substance which is most likely to be a network solid is

- A) I
- B) II
- C) III
- \*D) IV

9) Ionic bonds may be considered to result from

- A) the union of atoms of equal ionization energy
- \*B) the transfer of one or more electrons from one atom to another
- C) the sharing of electrons by atoms
- D) the alkali metals reacting with the alkaline earths

10) A solid has a very high melting point. This indicates that the substance must be

- A) a metal
- B) an ionic crystal
- \*C) held together by strong forces
- D) a molecular crystal

11) Most metals can best be described as

- A) brittle, dull and dense
- B) soft, powdery and light
- \*C) hard, shiny and dense
- D) flexible, powdery and dense

12A.3.

12) Diamond and graphite are forms of carbon. The former is very hard and the latter conducts electricity to some extent. Both are

- A) metals
- \*B) covalent network solids
- C) ionic crystals
- D) molecular solids

13) The molecule  $\text{CO}_2$  (carbon dioxide)

- A) is bent
- \*B) is linear
- C) has two non-bonding electrons
- D) has one double and one single bond

14) The compound that is most likely to contain covalent bonds is

- A) sodium chloride ( $\text{NaCl}$ )
- B) magnesium fluoride ( $\text{MgF}_2$ )
- C) beryllium oxide ( $\text{BeO}$ )
- \*D) sulfur(IV) oxide ( $\text{SO}_2$ )

15) The formula of cyanic acid is  $\text{HOCN}$ .

The Lewis (electron dot) representation for cyanic acid is

- \*A)  $\text{:N:::C:\ddot{O}:H}$
- B)  $\text{:C::N:\ddot{O}:H}$
- C)  $\text{:C:::O:\ddot{N}:H}$
- D)  $\text{H:C::\ddot{O}:\ddot{N}:}$

12A.3.

16) Diamond and graphite are examples of

- A) isotopes
- \*B) allotropes
- C) anhydrides
- D) isobars

17) Consider the following data for four substances:

SUBSTANCE	MELTING Point ( $^{\circ}\text{C}$ )	BOILING Point ( $^{\circ}\text{C}$ )	ELECTRICAL CONDUCTIVITY	
			Solid	Liquid
I	776	1500	poor	good
II	-39	356	good	good
III	-190	-42	poor	poor
IV	1420	2355	poor	poor

The substance that is most likely to be a covalent network solid is

- A) I
- B) II
- C) III
- \*D) IV

18) The diagram that describes an element which would be most likely to form metallic bonds is

- A)  $\text{:X:}$
- \*B)  $\text{X}\cdot$
- C)  $\ddot{\text{X}}\cdot$
- D)  $\ddot{\text{X}}\text{:}$

12A.3.

19) Which of the following is an element consisting of diatomic molecules?

- A) copper
- \*B) hydrogen
- C) helium
- D) silicon

20) Ionic bonds are caused or explained most directly by

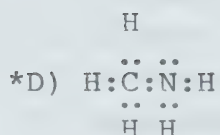
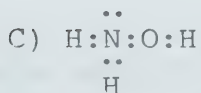
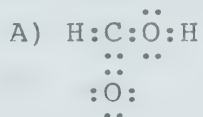
- A) the union of atoms of the same electronegativity
- \*B) the transfer of one or more electrons from one atom to another
- C) the sharing of electrons by atoms
- D) electrolysis

21) The shape of the ammonia ( $\text{NH}_3$ ) molecule is

- A) linear
- B) trigonal planar
- \*C) trigonal pyramidal
- D) tetrahedral

12A.3.

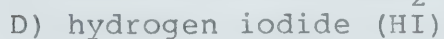
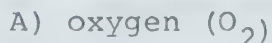
22) Which one of the following is an example of a correct electron dot (Lewis) structure?



23) Which one of the following compounds contains the most polar covalent bond?



24) Which one of the following compounds has a co-ordinate covalent bond?



12A.3.

- 25) The best example of a molecular solid in which the intermolecular bonding is only van der Waals forces is
- A) potassium iodide (KI)
  - \*B) carbon dioxide ( $\text{CO}_2$ )
  - C) hydrogen sulfide ( $\text{H}_2\text{S}$ )
  - D) ammonia ( $\text{NH}_3$ )
- 26) Metals usually tend to
- A) share electrons
  - B) gain electrons
  - \*C) form positive ions
  - D) form negative ions
- 27) A bond in which atoms share a pair of electrons is a(n)
- A) electrovalent bond
  - \*B) single covalent bond
  - C) ionic bond
  - D) binary bond
- 28) When water is vaporized, the smallest particle able to exist and maintain the properties of water is called a(n)
- A) atom
  - B) proton
  - \*C) molecule
  - D) nucleus

12A.3.

29) An example of a compound that can exist as a molecular solid is

- A) BaO
- B)  $\text{CaI}_2$
- \*C)  $\text{PBr}_3$
- D)  $\text{Cs}_2\text{S}$

30) A molecule of  $\text{CO}_2$  (carbon dioxide) is

- \*A) linear and nonpolar
- B) linear and polar
- C) V-shaped and polar
- D) pyramidal and polar

31) The bonding electrons are located farthest from the central position of the bond in bonds that are

- A) between identical atoms
- B) nonpolar covalent
- C) polar covalent
- \*D) ionic

32) The bonds that hold together the atoms in liquid helium are

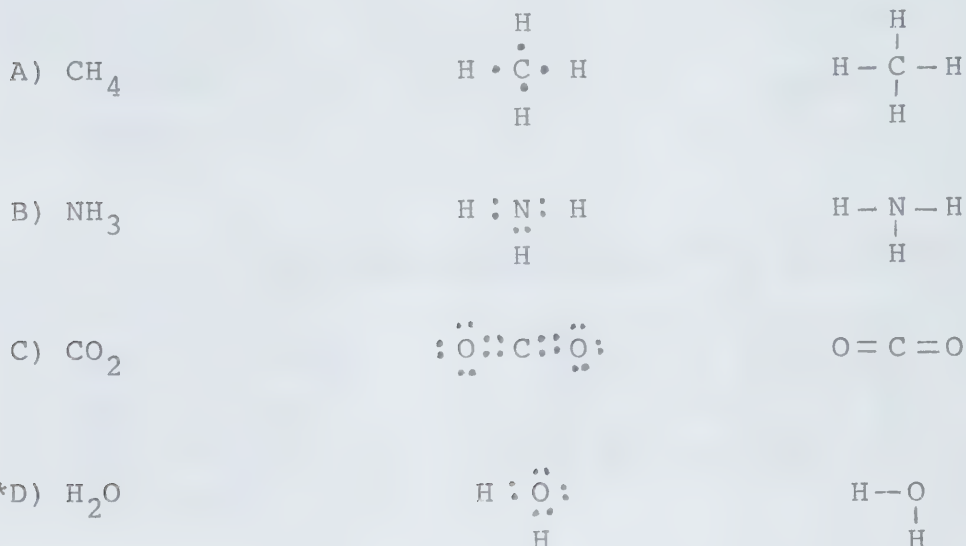
- A) ionic bonds
- B) covalent bonds
- C) hydrogen bonds
- \*D) Van der Waals bonds

33) The only ionic solid in the following list is

- \*A) calcium bromide,  $\text{CaBr}_2(\text{s})$
- B) boron(III) fluoride,  $\text{BF}_3(\text{s})$
- C) carbon tetrabromide,  $\text{CBr}_4(\text{s})$
- D) silicon tetrachloride,  $\text{SiCl}_4(\text{s})$

12A.3.

- 34) Which one of the following items correctly indicates both the correct electron dot (Lewis) diagram and the correct structural ("dash") diagrams for the molecules illustrated?



- 35) The substance listed below that is a gas at room temperature and 101 kPa is

- A) water (H<sub>2</sub>O)
- B) sucrose (C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>)
- C) mercury (Hg)
- \*D) neon (Ne)

- 36) Van der Waals Forces are

- A) intramolecular forces of attraction which cause molecules to condense
- B) forces between the extra pairs of electrons on F, O or N and neighbouring molecules
- \*C) the attraction of electrons in one molecule for the nuclei of atoms in neighbouring molecules
- D) stronger than ionic bonds

12A.3.

37) A crystal lattice may be best defined as a

- A) large crystal
- \*B) three dimensional pattern which shows how the particles of the crystal are arranged
- C) molecule of the solid
- D) positive and negative ions in a repeating pattern

38) Solid sodium chloride (NaCl) is a poor conductor of electricity. When melted or dissolved in water NaCl becomes a good conductor of electricity. Which of the following statements concerning this situation is true?

- A) Molten sodium chloride consists of molecules.
- \*B) When sodium chloride dissolves, the attractive force of the water pulls apart the ionic lattice of the solid NaCl.
- C) In aqueous solution,  $\text{Na}^+(\text{aq})$  and  $\text{Cl}^-(\text{aq})$  ions are attracted to each other and form NaCl molecules.
- D) If an electric current is passed through the solution,  $\text{Na}^+(\text{aq})$  ions will be attracted to the positive electrode.

39) Valence electrons in metals are free to move readily from atom to atom. Which of the following properties of metallic elements are best explained by the free movement of valence electrons?

- A) atomic mass of the elements
- B) atomic number of the elements
- \*C) conductivity of electric current
- D) position in the periodic table

12A.3.

40) Consider the following properties of four substances

<u>SUBSTANCE</u>	MELTING POINT (K)	BOILING POINT (K)	ELECTRICAL CONDUCTI- VITY OF SOLID	ELECTRICAL CONDUCTI- VITY OF LIQUID	SOLUBILITY IN WATER
1	1050	1770	poor	good	soluble
2	234	629	good	good	low solubility
3	1230	2220	good	good	low solubility
4	1690	2630	poor	poor	low solubility

Which of these substances is probably a covalently bonded network solid?

- A) 1
- B) 2
- C) 3
- \*D) 4

12A.3.

41) Molecules of the inert gases are unique because they are

- \*A) monatomic
- B) diatomic
- C) amorphous
- D) ionic

42) Diamond is an example of

- \*A) a covalent crystal
- B) an ionic crystal
- C) a molecule
- D) a metal

43) An example of a molecular solid is

- \*A)  $I_2$  (iodine)
- B) NaCl (sodium chloride)
- C) C (carbon)
- D) Na (sodium)

44) A molecule

- A) is the smallest possible particle of an element
- B) must consist of only two atoms
- \*C) may be polar
- D) has uniform charge distribution

45) In ice, the molecules of  $H_2O(s)$  are held together in the solid lattice by

- A) ionic bonds
- \*B) hydrogen bonds
- C) covalent bonds
- D) oxygen bonds

12A.3.

46) An example of an ionic compound is

- \*A) NaCl (sodium chloride)
- B) CCl<sub>4</sub> (carbon tetrachloride)
- C) H<sub>2</sub>O (water)
- D) H<sub>2</sub>S (hydrogen sulfide)

47) The following table sets out information about some common substances.

	Melting Point	Electrical Conductivity of solid	Electrical Conductivity of liquid	Electrical conductivity of solution in water
1) C <sub>6</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>2</sub> (xylene)	-25°C	poor	poor	insoluble
2) HI (hydrogen iodide)	-51°C	poor	poor	good
3) KBr (potassium bromide)	730°C	poor	good	good
4) Ni (nickel)	1455°C	good	good	insoluble
5) NaI (sodium iodide)	651°C	poor	good	good
6) H <sub>2</sub> O (water)	0°C	poor	poor	----
7) Ag (silver)	961°C	good	good	insoluble
8) Cu (copper)	1083°C	good	good	insoluble
9) MgCl <sub>2</sub> (magnesium chloride)	712°C	poor	good	good

The substances which consist of discrete ions are

- \*A) 3, 5, 9
- B) 4, 7, 8
- C) 2, 3, 5
- D) 2, 3, 9

48) Which one of the following substances exhibits the greatest degree of ionic bonding?

- A) H<sub>2</sub>O(s) (ice)
- B) NH<sub>3</sub>(l) (liquid ammonia)
- C) SiO<sub>2</sub>(s) (solid silicon dioxide)
- \*D) CsF(s) (solid cesium fluoride)

12A.3.

49) The strongest ionic bonds exist between .

- A) sodium and fluorine
- \*B) potassium and fluorine
- C) lithium and fluorine
- D) chlorine and fluorine

50) The following table gives information about the properties of some pure substances.

<u>Pure Substance</u>	<u>Electrical Conductivity</u>			<u>Melting Point</u>	
	<u>Solid</u>	<u>Liquid</u>	<u>Solution in Water</u>	<u>(K)</u>	<u>(°C)</u>
1	Poor	Good	Good	1074	801
2	Good	Good	Not soluble	1723	1450
3	Good	Good	Not soluble	1813	1540
4	Poor	Poor	Good	162	-101
5	Poor	Good	Good	1043	770
6	Poor	Poor	Not soluble	392	119
7	Poor	Poor	Not soluble	1683	1410

The pure substances whose structure are most likely to be composed of ions are

- A) 4, 6, 7
- \*B) 1, 5
- C) 1, 2, 3, 5
- D) 1, 4, 5,

51) In the H-Cl bond, the two bonding electrons are located

- A) closer to the hydrogen than to the chlorine atom
- \*B) closer to the chlorine atom than to the hydrogen atom
- C) at the same distance from both the hydrogen and chlorine atoms
- D) at opposite ends of the bonds

12A.3.

52) The major forces holding particles together in crystals of sodium chloride (NaCl) are called

- A) magnetic
- B) van der Waals
- C) covalent
- \*D) electrovalent

53) The water molecule is said to be

- A) ionic
- B) electrovalent
- \*C) a dipole
- D) a macromolecule

54) The smallest particle of an element which can take part in a chemical change is called a(n)

- A) electron
- B) ion
- C) molecule
- \*D) atom

55) The primary units of pure substances involving covalent bonds are called

- A) ionic crystals
- B) metals
- C) ion pairs
- \*D) molecules

12A.3.

56) In a diatomic  $H_2$  (hydrogen) molecule, each hydrogen atom has the same outer shell electron configuration as an atom of the gas

- A)  $O_2$  (oxygen)
- B)  $Cl_2$  (chlorine)
- C)  $NH_3$  (ammonia)
- \*D) He (helium)

57) The polar molecule in the following list is

- \*A)  $PCl_3$
- B)  $PCl_5$
- C)  $CO_2$
- D)  $SF_6$

58) Which of the following compounds exhibits the greatest covalent character?

- \*A) NO (nitrogen(II) oxide)
- B) MgO (magnesium oxide)
- C) CsF (cesium fluoride)
- D) NaCl (sodium chloride)

59) In which one of the following types of bond are the particles held together by the sharing of electron pairs?

- A) ionic bonds
- B) metallic bonds
- \*C) covalent bonds
- D) hydrogen bonds

12A.3.

60) Which one of the following groups in the Periodic Table contains elements which form mainly covalent compounds?

- A) I
- B) II
- C) VIII
- \*D) IV

61) Nonpolar compounds would be expected to

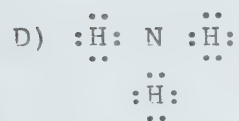
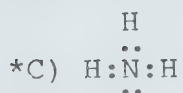
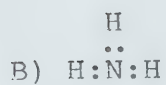
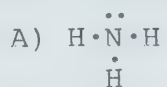
- A) conduct an electric current
- B) have high melting points
- C) dissolve in water to form ions
- \*D) have low solubilities in water

62) Covalent bonds are due to the

- A) attraction between ions of opposite charge
- B) gain or loss of electrons by atoms
- C) transfer of electrons from one atom to another
- \*D) sharing of two electrons by two atoms

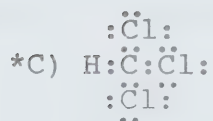
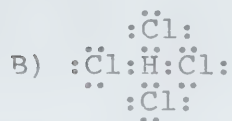
12A.3.

63) Which of the following is the correct Lewis dot diagram for ammonia ( $\text{NH}_3$ )?



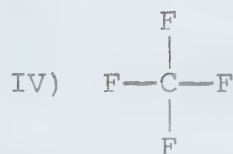
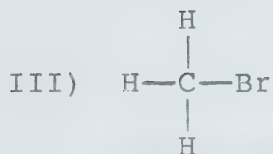
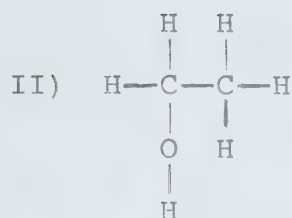
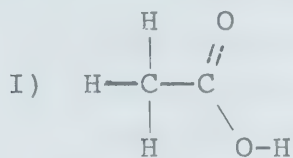
12A.3.

64) Which one of the following Lewis dot diagrams represents a molecule with the most stable electron configuration?



12A.3.

65) The compound that would be expected to have the highest boiling point is



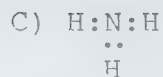
- \*A) I
- B) II
- C) III
- D) IV

66) The best electron dot (Lewis) diagram for  $\text{CO}_2$  (carbon dioxide) is

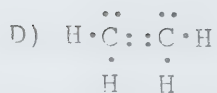
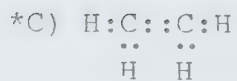
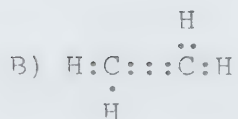
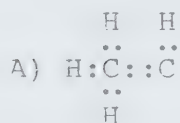


12A.3.

67) Which one of the following electron dot diagrams is correct?



68) The electron dot (Lewis) diagram for  $\text{C}_2\text{H}_4$  (ethylene) is



12A.3.

69) A triple covalent bond

- A) joins 3 atoms
- B) results in a triatomic molecule
- \*C) contains 6 electrons
- D) occurs only in ionic crystals

70) The bonds **between** molecules in solid nitrogen are referred to as

- A) ionic bonds
- B) covalent bonds
- C) hydrogen bonds
- \*D) van der Waals forces

71) The term electronegativity refers to the fact that

- A) an electric current is a stream of negative particles called electrons
- B) some elements conduct electricity while others do not
- C) it requires energy to remove electrons from neutral atoms
- \*D) the attraction for electrons in a bond formed between two different atoms can be uneven

72) The heat of vapourization of water is almost five times greater than that of oxygen. This means that

- \*A) the forces between water molecules are greater than those between oxygen molecules
- B) the forces within water molecules are smaller than those within oxygen molecules
- C) water evaporates more readily than oxygen
- D) a water molecule has more mass than an oxygen molecule

12A.3.

73) Diamond and graphite are said to be allotropes of carbon because they are

- A) both carbon, but one is purer than the other
- B) both pure compounds of carbon
- \*C) different pure forms of carbon with different physical properties
- D) both pure carbon but have very different chemical properties

74) The attractive force resulting from the sharing of a pair of electrons by the nuclei of two atoms is called

- A) an electrovalent bond
- B) an ionic bond
- \*C) a covalent bond
- D) van der Waals force

75) Diamond is an example of a(n)

- \*A) covalent crystal
- B) ionic crystal
- C) molecule
- D) metal

12A.3.

76) Consider the electron configurations for five elements

Element	Electron Configuration
V	2, 8, 6
W	2, 8, 7
X	2, 8, 8
Y	2, 8, 8, 1
Z	2, 8, 8, 2

The elements most likely to form covalent compounds are

- \*A) V and W
- B) V and Y
- C) X and Z
- D) Y and Z

77) Crystals that have high melting points, are generally hard, not malleable and poor conductors of electricity are

- I ionic crystals
- II nonpolar molecular crystals
- III polar molecular crystals
- IV covalent network crystals

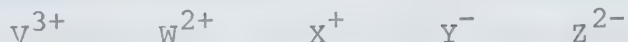
- A) II and III
- B) I and III
- C) II and IV
- \*D) I and IV

78) The following data were obtained for a certain substance: melting point 1970 K, boiling point 2870 K, non conducting as a solid and liquid and insoluble in water. This substance has properties best representative of

- A) ionic crystals
- B) covalent molecules
- C) metals
- \*D) network solids

12A.3.

79) The following is a list of the usual charge found on the ions of a series of elements:



Which elements are most likely to be metals?

- A) V and W
- \*B) V, W and X
- C) X and Y
- D) Y and Z

80) When the alkali metal elements of group I are put in water, they form

- A) hydrogen only
- B) hydrogen and a non metal
- C) a metallic hydroxide only
- \*D) a metallic hydroxide and hydrogen

81) The bonds that involve positive particles in a "sea" of mobile electrons are referred to as

- A) ionic bonds
- \*B) metallic bonds
- C) covalent bonds
- D) hydrogen bonds

82) Copper is a good conductor of electricity. This indicates that

- \*A) it contains free-moving electrons
- B) it contains free-moving ions
- C) it contains free-moving protons
- D) all of its particles are held in position by strong forces

12A.3.

- 83) In a metallic crystal, the particles at the lattice points are
- A) atoms
  - B) positive and negative ions
  - C) negative ions
  - \*D) positive ions
- 84) A substance that is made up of positive ions bonded together by electrons which move freely from ion to ion is
- \*A) Au (gold)
  - B) NaCl (sodium chloride)
  - C) P<sub>4</sub> (phosphorus)
  - D) Kr (krypton)
- 85) The aggregates which have positive ions and mobile electrons are
- A) ionic solids
  - B) non polar molecular solids
  - C) network solids
  - \*D) metallic solids
- 86) Which one of the properties of metallic elements is best **explained** by the model: "outer shell electrons in metals are free to move readily from ion to ion."?
- A) atomic mass of the elements
  - B) atomic number of the elements
  - \*C) conductivity of electric current
  - D) position in the Periodic table

12A.3.

87) Metals are generally better conductors of both heat and electricity than non-metals because

- A) metals usually have higher melting points
- \*B) valence electrons in metals are more mobile than in non-metals
- C) atoms of metals usually contain more electrons
- D) ionization energies of metals are usually greater than those of non-metals

12A.3.

88) If a mass of water is subdivided or vaporized the smallest particle able to exist physically which still retains the original composition of water is called

- \*A) a molecule
- B) an atom
- C) an ion
- D) a nucleus

89) An element with atomic number 16 is represented by the symbol "X". The electron dot representation of element 16 is

- A) X:
- B)  $\begin{array}{c} \cdot\cdot \\ :\ddot{X}: \\ \cdot\cdot \end{array}$
- \*C)  $\begin{array}{c} \cdot\cdot \\ :\ddot{X}: \end{array}$
- D)  $\begin{array}{c} \cdot\cdot \\ :\ddot{X} \end{array}$

90) Which of the following electron configurations represents the element whose neutral atoms have the smallest average atomic radius?

- A) 2, 8, 1
- B) 2, 8, 3
- C) 2, 8, 7
- \*D) 2, 8, 8

91) NaCl belongs to the atomic aggregate type known as

- A) covalent molecule
- \*B) ionic crystal
- C) covalent crystal
- D) network solid

12A.3.

92) Forces between the atoms within a molecule are

- A) van der Waals forces
- \*B) intramolecular forces
- C) ionic forces
- D) intermolecular forces

Questions 9198 to 9200 refer to the following table which lists some properties of substances

Substance	Melting Point ( $^{\circ}\text{C}$ )	<u>Electrical Conductivity</u>		Water Solubility
		in solid	in liquid	
A	776	low	high	high
B	-198	low	low	low
C	961	high	high	low
D	1640	low	low	low

93) Which substance is most likely to be an ionic solid?

- \*A) A
- B) B
- C) C
- D) D

94) Which substance is most likely to be a network solid?

- A) A
- B) B
- C) C
- \*D) D

12A.3.

95) Which substance is most likely to be a metal?

- A) A
- B) B
- \*C) C
- D) D

The following table refers to questions 9237 - 9239.

Substance	Boiling Point (°C)	Solubility in Water	Electrical Conductivity	
			(Solid)	(Liquid)
A	2212 <sup>o</sup>	low	high	high
B	78 <sup>o</sup>	high	low	low
C	2590 <sup>o</sup>	low	low	low
D	-45 <sup>o</sup>	low	low	low

96) The substance which can best be represented as a set of positive ions held together by a mobile pool of valence electrons is

- \*A) A
- B) B
- C) C
- D) D

97) Which substance may be an organic hydrocarbon consisting of small molecules?

- A) A
- B) B
- C) C
- \*D) D

12A.3.

- 98) Which substance may be a network of atoms bonded throughout by covalent bonds in a brittle crystal arrangement
- A) A
  - B) B
  - \*C) C
  - D) D
- 99) The property that metals have which permits them to be hammered into thin sheets is
- A) ductility
  - \*B) malleability
  - C) hardness
  - D) flexibility
- 100) The property of a metal which allows it to be stretched into wire is referred to as
- \*A) ductility
  - B) conductivity
  - C) malleability
  - D) flexibility
- 101) What type of aggregate will most likely be formed by the reaction of two elements, one with low ionization energy and few valence electrons, and the other with a high ionization energy?
- \*A) ionic crystal
  - B) covalent molecule
  - C) covalent crystal
  - D) metallic solid

12A.3.

102) A substance is found to be a good conductor of electricity in the molten state but a poor conductor in the solid state. The category it would most likely belong to is

- A) molecular solid
- B) network solid
- \*C) ionic crystal
- D) metallic solid

103) Which of the following combinations would yield a compound with the **most** ionic character?

- \*A) sodium and fluorine
- B) sodium and oxygen
- C) sodium and nitrogen
- D) sodium and sulfur

104) The valence of boron in the compound  $B_2H_6$  is

- A) 1
- B) 2
- \*C) 3
- D) 6

105) The total number of atoms of oxygen represented in the formula  $MgSO_4 \cdot 7H_2O$  is

- \*A) 11
- B) 7
- C) 5
- D) 4

12A.3.

106) The total number of atoms represented in the formula  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$  is

- A) 17
- B) 23
- C) 33
- \*D) 43

107) The number of atoms represented by  $2\text{Al}_2(\text{SO}_4)_3$  is

- A) 14
- B) 17
- C) 19
- \*D) 34

108) The number of atoms represented by the formula  $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$  (ammonium acetate) is

- A) 4
- B) 5
- \*C) 12
- D) 15

109) All chemical bonds result from

- A) equal sharing of electrons by two or more atoms
- B) electrons being gained by one atom and lost by another
- C) two atoms approaching each other and gaining energy
- \*D) electrons being simultaneously attracted by two or more nuclei

12A.3.

110) The number of atoms represented by the formula  $K_3Fe(CN)_6$  is

- A) 36
- \*B) 16
- C) 10
- D) 4

111) The number of atoms represented by the formula  $Al(OH)_3$  is

- A) 1
- \*B) 7
- C) 3
- D) 9

112) The total number of atoms represented by the formula  $Na_2CO_3 \cdot 10H_2O$  is

- A) 38 atoms
- \*B) 36 atoms
- C) 15 atoms
- D) 4 atoms

113) Sharing of electrons in forming a bond always involves

- A) formation of positive and negative ions
- B) shared electrons located equidistant from both nuclei
- \*C) lower energy content for bonded than unbonded atoms
- D) shared electrons being attracted more by one atom

114) Two atoms share a pair of electrons; this bond is called

- A) a double bond
- B) a binary bond
- \*C) a covalent bond
- D) an electrovalent bond

12A.3.

115) In a diatomic hydrogen molecule, each hydrogen atom has an electron structure which resembles the gas

- \*A) helium
- B) krypton
- C) argon
- D) neon

116) A covalent bond consists of

- A) a shared pair of protons
- \*B) a shared pair of electrons
- C) an octet of electrons
- D) two electrovalent ions

117) What forces or bonds are primarily responsible for holding the two oxygen atoms together in a molecule of  $O_2$ ?

- A) ionic bonds
- B) metallic bonds
- C) Van der Waals Forces
- \*D) covalent bonds

118) A covalent bond is best described as

- A) the bond between two oppositely charged ions
- B) the bond formed when an alkali metal reacts with a halogen
- C) the bond between small stable particles like neon atoms
- \*D) a pair of electrons shared between atoms

12A.3.

119) The bond in an  $N_2$  molecule can be described as

- A) an ionic bond
- B) a polar bond
- C) a double bond
- \*D) a triple bond

120) The shape of the molecule of methane ( $CH_4$ ) is best described as

- A) square
- \*B) tetrahedral
- C) rectangular
- D) octahedral

121) The structural formula for the compound  $CH_2O$  is

- A)  $H - C = O - H$
- B)  $H = C = O - H$
- \*C)  $\begin{array}{c} H \\ \diagdown \\ C=O \\ \diagup \\ H \end{array}$
- D)  $\begin{array}{c} H \\ \diagdown \\ C-O \\ \diagup \\ H \end{array}$

122) The bond that holds atoms together in molecules represents part of the energy of the molecule. In breaking this bond

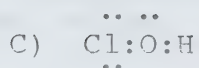
- \*A) energy is required
- B) energy is released
- C) new energy is formed
- D) heat and light are given off

12A.3.

123) Given the following pure substances and their bond dissociation energies, which substance is the most difficult to decompose into separate atoms?

- A) HI 295 kJ/mol
- B) HCl 428 kJ/mol
- C) H<sub>2</sub> 432 kJ/mol
- \*D) O<sub>2</sub> 494 kJ/mol

124) The electron dot representation for HClO (hypochlorous acid) is most likely to be





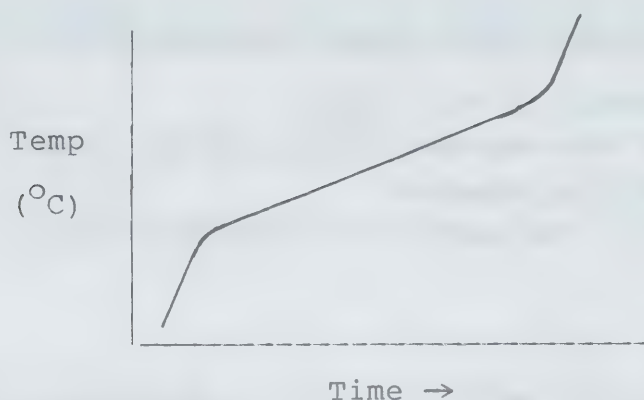


12A.4.

- 1) The vapour pressure of a liquid depends on the
  - \*A) temperature of the liquid
  - B) area of the exposed surface of the liquid
  - C) atmospheric pressure
  - D) volume of the container above the liquid
  
- 2) The vapour pressure of a liquid is independent of the
  - A) chemical composition of the liquid
  - \*B) atmospheric pressure
  - C) temperature
  - D) purity of the liquid
  
- 3) The volume of a confined gas can be reduced, at constant temperature, by increasing the pressure on the gas. The change in volume may best be explained by the fact that gas molecules
  - A) take up space
  - B) are in constant motion
  - C) collide without loss of energy
  - \*D) are relatively far apart

12A.4.

4) The diagram illustrates the melting curve of wax.



The shape of the graph indicates that wax

- \*A) is an impure substance
  - B) is a compound
  - C) is a pure substance
  - D) has a sharp, definite melting point
- 5) A piece of dry ice is allowed to stand at room temperature until it all disappears. This process is called
- A) vaporization
  - \*B) sublimation
  - C) condensation
  - D) fusion
- 6) A phase change directly from the solid to the gaseous state is called
- A) chemical change
  - \*B) sublimation
  - C) fusion
  - D) boiling

12A.4.

7) Which one of the following statements about the evaporation process is true?

- A) The liquid is much more compressible than the vapour.
- \*B) The molecules become separated to relatively great distances during evaporation.
- C) The density of the liquid is less than that of the vapour.
- D) The molecules of vapour have a different chemical composition than those in the liquid.

8) The vapour pressure of water ( $\text{H}_2\text{O}$ ) at 292 K is 2.200 kPa. Some oxygen ( $\text{O}_2$ ) is collected over water at 292 K and the total pressure of the gas is 101.1 kPa. The pressure due to the oxygen is

- \*A) 98.9 kPa
- B) 99.9 kPa
- C) 101.1 kPa
- D) 103.3 kPa

9) Which of the following statements are correct?

- I) Table salt is made up of molecules
  - II) Most gases, most liquids and some solids are made up of molecules
  - III) At the same temperature, the average kinetic energy of the molecules of all gases is the same
  - IV) At the same temperature, the average velocity of the molecules of all gases is the same
- 
- A) I and III
  - \*B) II and III
  - C) I and IV
  - D) II and IV

12A.4.

10) The expression "absolute zero" refers to

- A) the temperature at which water freezes
- B)  $-273\text{ K}$
- C)  $0^{\circ}\text{C}$
- \*D)  $0\text{ K}$

11) The property of gases which accounts for pressure is

- A) the space between molecules
- B) the density of the gas
- \*C) the motion of the gas molecules
- D) the identity of the gas

12) Real gases behave most like ideal gases when

- A) the pressure is high and the temperature is low
- \*B) the pressure is low and the temperature is high
- C) the pressure is low and the temperature is low
- D) the pressure is high and temperature is high

13) If a sealed one litre jar of gas is cooled, the molecules

- A) move farther apart
- B) collide more often with the walls of the jar
- C) increase their vibrational motion
- \*D) move more slowly

12A.4.

14) Consider two identical flasks, both at  $25^{\circ}\text{C}$  and 101 kPa pressure. One contains  $\text{SO}_2$  gas and the other  $\text{O}_2$  gas. Which of the following statements about the gases contained in the flasks is true assuming ideal behaviour?

- A) A different number of molecules is contained in each flask.
- \*B) The average kinetic energy of the molecules is the same in both flasks.
- C) The average velocity of the molecules is the same in both flasks.
- D) The flask filled with  $\text{SO}_2$  gas will have the same mass as the flask filled with  $\text{O}_2$  gas.

15) When both gases (1 L of hydrogen and 1 L of oxygen) are measured at STP, 1 L of  $\text{O}_2$  (oxygen) contains

- \*A) the same number of molecules as 1 L of  $\text{H}_2$  (hydrogen)
- B)  $1/16$  as many molecules as 1 L of  $\text{H}_2$
- C) the same number of molecules as 16 L of  $\text{H}_2$
- D) 16 times as many molecules as 1 L of  $\text{H}_2$

16) According to Boyle's Law, the volume of a given mass of gas is inversely proportional to the pressure, at constant temperature. Hence, it would be expected that an increase in the pressure exerted on a gas would cause the density to

- \*A) increase
- B) decrease
- C) remain the same
- D) increase for some gases, decrease for others

17) Charles' Law can be represented by the equation

- \*A)  $V_1 T_2 = V_2 T_1$
- B)  $V_2 T_2 = V_1 T_1$
- C)  $V_1 P_1 = V_2 P_2$
- D)  $V_1 P_2 = V_2 P_1$

12A.4.

- 18) At a constant pressure, 20 L of a gas at 400 K are expanded to 30 L. The final temperature of the gas must be
- A) 267 K
  - B) 390 K
  - \*C) 600 K
  - D) 4000 K
- 19) A quantity of gas collected at 298 K and 101 kPa occupies a volume of 200 mL. If the pressure on the gas is doubled and its temperature is raised to 596 K, the volume occupied by the gas will be
- A) 50.0 mL
  - B) 100 mL
  - \*C) 200 mL
  - D) 800 mL
- 20) When the pressure exerted on 1 L of an ideal gas is tripled, and the absolute temperature is doubled, the volume becomes
- A)  $\frac{1}{6}$  L
  - \*B)  $\frac{2}{3}$  L
  - C)  $\frac{3}{2}$  L
  - D) 6 L
- 21) At a constant temperature, 600 mL of an ideal gas is at a pressure of 101 kPa. If the volume is decreased to 300 mL the pressure of the gas will be
- A) 25.3 kPa
  - B) 50.5 kPa
  - C) 101 kPa
  - \*D) 202 kPa

12A.4.

22) At 101 kPa pressure and at a temperature of 253 K; the density of a gas

- A) is the same as at standard conditions
- B) is less than at standard conditions
- \*C) is greater than at standard conditions
- D) is about 20 times less than at standard conditions

23) The mass of a fixed quantity of a gas

- A) increases when the volume increases, at constant temperature
- B) decreases when the absolute temperature decreases, at constant pressure
- \*C) does not change at any temperature and pressure
- D) decreases as the density increases

24) A volume of 25.0 L of an ideal gas is at 202 kPa pressure and 300 K. At standard temperature and pressure, the volume of the gas would be

- A)  $\frac{25.0 \times 101 \times 300}{202 \times 273}$  L
- \*B)  $\frac{25.0 \times 202 \times 273}{101 \times 300}$  L
- C)  $\frac{25.0 \times 101 \times 273}{202 \times 300}$  L
- D)  $\frac{25.0 \times 202 \times 300}{101 \times 273}$  L

25) The vapour pressure of a liquid depends on the

- \*A) temperature of the liquid
- B) area of the exposed surface of the liquid
- C) atmospheric pressure
- D) volume of the container above the liquid

12A.4.

26) The vapour pressure of a liquid depends upon

- A) the external pressure on the liquid
- B) the surface area of the liquid
- \*C) the temperature of the liquid
- D) the amount of liquid present

27) Which of the state(s) of matter fit(s) the following characteristics?

- diffusion occurs
- no fixed shape
- translational motion takes place

- A) solid
- B) liquid
- C) gas
- \*D) liquid and gas

28) At the same temperature, how many times faster do He atoms (helium, relative atomic mass 4.0) diffuse than SO<sub>2</sub> molecules (sulphur dioxide, relative molecular mass 64)?

- A) 0.25
- B) 2.0
- C) 0.50
- \*D) 4.0

29) Suppose a certain volume of H<sub>2</sub> (hydrogen) contains 2000 molecules. The same volume of O<sub>2</sub> (oxygen) at the same temperature and pressure would contain

- A) 500.0 molecules
- B) 1000 molecules
- \*C) 2000 molecules
- D)  $6.025 \times 10^{23}$  molecules

12A.4.

- 30) The boiling point of oxygen is  $-183^{\circ}\text{C}$ , and its freezing point is  $-219^{\circ}\text{C}$ . Within 50 K of absolute zero, oxygen is a
- A) gas
  - B) solution
  - C) liquid
  - \*D) solid
- 31) The pressure due to the molecules of a substance in the vapour above the corresponding liquid is called the
- A) air pressure
  - \*B) vapour pressure
  - C) oxygen pressure
  - D) saturated pressure
- 32) At constant volume, the pressure of a gas Y increases with temperature because
- \*A) the molecules of Y move faster
  - B) the volume of Y increases
  - C) collisions of Y molecules are more elastic
  - D) the mass of Y increases
- 33) The effect of gases which is due to constant bombardment of the walls of the container by moving molecules is its
- A) density
  - B) mass
  - \*C) pressure
  - D) diffusion

12A.4.

34) As the temperature of a gas, in an elastic container, rises the

- \*A) vapour density of the gas decreases
- B) density of the gas increases
- C) vapour density of the gas increases
- D) vapour density of the gas remains the same

35) If the temperature remains constant while the volume of a given amount of gas is tripled, the pressure will be

- A) three times the original pressure
- B)  $\frac{2}{3}$  of the original pressure
- \*C)  $\frac{1}{3}$  of the original pressure
- D) the same as the original pressure

36) The density of a gas

- A) varies inversely with pressure at constant temperature
- B) varies directly with the absolute temperature at constant pressure
- \*C) varies inversely with the absolute temperature at constant pressure
- D) decreases as the mass of the gas increases

37) The density of an unknown gas is 1.34 g/L at STP. The gas could be

- A)  $F_2$  (fluorine; relative molecular mass 38)
- B)  $Cl_2$  (chlorine; relative molecular mass 71)
- C)  $CH_4$  (methane; relative molecular mass 16)
- \*D)  $CH_2O$  (formaldehyde; relative molecular mass 30)

12A.4.

38) The density of  $\text{CO}_2$  (carbon dioxide; relative molecular mass 44) gas at STP is

- A) 0.509 g/L
- B) 0.986 g/L
- C) 1.79 g/L
- \*D) 1.96 g/L

39) Which of the following gases diffuses most rapidly at STP?

- A)  $\text{NH}_3$  (ammonia)
- \*B)  $\text{H}_2$  (hydrogen)
- C)  $\text{CO}_2$  (carbon dioxide)
- D)  $\text{Cl}_2$  (chlorine)

40) As water freezes at 273 K the total volume of the ice-water system

- A) remains constant
- \*B) increases steadily
- C) decreases steadily
- D) the volume increases then decreases

41) Consider the melting of a quantity of ice in a beaker of water over a Bunsen burner flame. During the change from a solid to a liquid the temperature of the system

- A) rises
- B) falls
- \*C) stays the same
- D) varies with the amount of ice

12A.4.

42) On a winter day ice may change directly to vapour. Such a change is called

- A) freezing
- \*B) sublimation
- C) condensation
- D) fusion

43) Gases A and B are at the same temperature but gas A molecules are 4 times more massive than gas B molecules; the ratio of velocities of gas B: gas A is

- A) 4:1
- \*B) 2:1
- C) 16:1
- D) 1:16

44) The number of molecules in 1 L of  $O_2$  (oxygen gas) at STP is

- \*A) the same as the number of molecules in 1 L of hydrogen gas at STP
- B) 16 times as many as in 1 L of hydrogen gas at STP
- C)  $\frac{1}{16}$  as many as in 1 L of hydrogen gas at STP
- D)  $6.02 \times 10^{23}$

12A.4.

45) Which two of the following statements are correct?

- I) The volume of a given mass of gas varies directly as its absolute temperature when the pressure remains constant
  - II) When a gas is cooled, its molecules move faster
  - III) At constant volume, a decrease in pressure may be due to an increase in the number of molecules
  - IV) The molecules of a gas are in continuous motion
- A) I and III
  - B) II and III
  - \*C) I and IV
  - D) II and IV

46) The two physical changes involved in distillation are

- A) vaporization and boiling
- \*B) vaporization and condensation
- C) evaporation and sublimation
- D) heating and boiling

47) At a constant pressure, 10.0 L of a gas are cooled from 546 K to 273 K. The final volume will be

- \*A) 5.00 L
- B) 2.00 L
- C) 8.00 L
- D) 20.0 L

48) A sample of  $O_2$  (oxygen gas) occupies a volume of 600 mL. If the pressure exerted on the  $O_2$  is tripled while its temperature remains the same, the new volume of the oxygen will be

- \*A) 200 mL
- B) 300 mL
- C) 600 mL
- D)  $1.80 \times 10^3$  mL

12A.4.

49) A gas occupies 100 mL at 290 K. What will be its volume at 500 K if the pressure remains constant?

A)  $\frac{100 \times 290}{500}$  mL

\*B)  $\frac{100 \times 500}{290}$  mL

C)  $100 \times 500 \times 290$  mL

D)  $\frac{100}{500 \times 290}$  mL

50) What is the volume of 16 g of  $O_2$  (oxygen) gas at STP?

A) 2.24 L

\*B) 11.2 L

C) 22.4 L

D) 44.8 L

12A.4.

- 51) "The number of molecules contained in 15 mL of CO (carbon monoxide) gas equals the number of molecules contained in 15 mL of O<sub>2</sub> (oxygen) gas at STP." This statement illustrates which one of the following?
- \*A) Avogadro's Principle
  - B) Law of Multiple Proportions
  - C) Law of Constant Composition
  - D) Law of Conservation of Mass
- 52) If wet clothes are put outside on a clear day when the temperature is -10°C
- A) the clothes will freeze and hence not dry
  - B) the clothes will dry because the sun will heat them to near 100°C
  - \*C) the clothes will dry by freezing and sublimation of the water
  - D) the clothes will dry by condensation and evaporation of the water
- 53) Molecules in the liquid state experience
- A) rotational motion only
  - B) vibrational and limited rotational motion only
  - C) translational motion only
  - \*D) vibrational, rotational and translational motion
- 54) A vessel contains 2.50 mol of O<sub>2</sub> (oxygen gas), 0.50 mol of N<sub>2</sub>(g) (nitrogen gas) and 1.00 mol of CO<sub>2</sub> (carbon dioxide gas). The total pressure is 200 kPa. The partial pressure exerted by the O<sub>2</sub> in the mixture is
- \*A) 125 kPa
  - B) 150 kPa
  - C) 200 kPa
  - D) 250 kPa

12A.4.

55) Molecules are always

- A) colourless
- B) made of oxygen
- C) diatomic
- \*D) in motion

56) Condensation is a change

- A) of state from a gas to a solid
- \*B) in which energy is released
- C) in which energy is absorbed
- D) in chemical composition

57) "The pressure of a given mass of gas varies directly as the absolute (Kelvin) temperature if the volume is kept constant", is a statement of

- \*A) Charles' Law
- B) Gay-Lussac's Law
- C) Boyle's Law
- D) Avogadro's Principle

58) If the temperature of a sealed glass container of  $O_2$  (oxygen gas) is increased, the

- A) density of the gas increases
- B) density of the gas decreases
- \*C) average molecular velocity increases
- D) average molecular velocity decreases

12A.4.

59) At a constant pressure, 3.00 L of a gas are heated from 300 K to 382 K. The final volume of the gas is

- A) 1.00 L
- B) 2.36 L
- \*C) 3.82 L
- D) 9.00 L

60) The instrument used to measure changes in gas pressure is called a

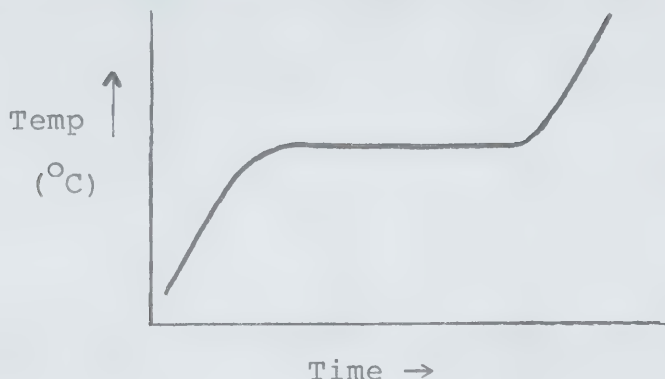
- A) hygrometer
- B) calorimeter
- \*C) manometer
- D) dosimeter

61) Two litres of  $H_2$  (hydrogen) are collected at a pressure of 80 kPa and a temperature of 300 K. The volume of this quantity of  $H_2$  gas, measured at 500 K and 50 kPa pressure, is given by the expression

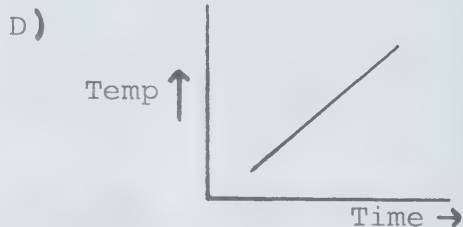
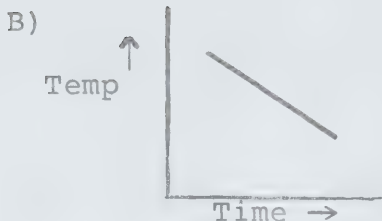
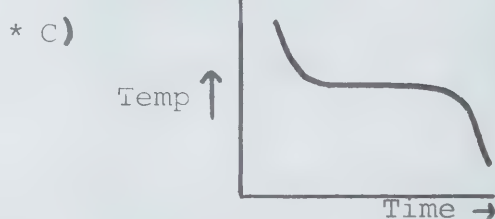
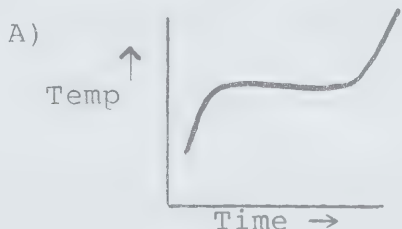
- A)  $2 \times \frac{80}{50} \times \frac{300}{500} \text{ L}$
- B)  $2 \times \frac{50}{80} \times \frac{500}{300} \text{ L}$
- C)  $2 \times \frac{50}{80} \times \frac{300}{500} \text{ L}$
- \*D)  $2 \times \frac{80}{50} \times \frac{500}{300} \text{ L}$

12A.4.

62) The following diagram illustrates the melting curve of tin.



Which of the following graphs best represents the solidification of tin?



63) Doubling the initial pressure, at constant temperature, under which 1000 mL of a gas was confined causes the volume of the gas to

- A) increase to double
- B) remain the same
- C) decrease very slightly
- \*D) decrease to half

12A.4.

64) Which one of the following statements is correct?

- A) The volume of a given mass of gas (at constant pressure) varies inversely as its absolute temperature.
- B) When a gas is cooled, its molecules move faster.
- \*C) At constant volume, an increase in pressure may be due to an increase in the number of molecules.
- D) The pressure exerted by a gas at constant volume is independent of its temperature.

65) The average velocity for hydrogen,  $\text{H}_2$ , molecules at 273 K is  $120 \times 10^3$  cm/s. Given that the relative molecular masses of  $\text{H}_2$  and  $\text{O}_2$  (oxygen) are 2.00 and 32.0 respectively, what is the average velocity for  $\text{O}_2$  at 273 K?

- A)  $20.0 \times 10^3$  cm/s
- \*B)  $30.0 \times 10^3$  cm/s
- C)  $341 \times 10^3$  cm/s
- D)  $480 \times 10^3$  cm/s

66) When 2.24 L of carbon dioxide,  $\text{CO}_2$ , at 546 K and 50.5 kPa is converted to STP, its volume is

- \*A)  $2.24 \times \frac{273}{546} \times \frac{50.5}{101}$  L
- B)  $2.24 \times \frac{546}{273} \times \frac{101}{50.5}$  L
- C)  $2.24 \times \frac{1}{2} \times \frac{1}{2}$  L
- D)  $2.24 \times \frac{546}{1} \times \frac{50.5}{101}$  L

12A.4.

67) Which one of the following statements is true?

- A) A decrease in pressure on a gas causes an decrease in volume.
- B) Absolute zero is  $-273\text{ K}$ .
- \*C) In a mixture of gases, the one with the most molecules exerts the most pressure.
- D) An increase in the pressure of a gas could be due to a decrease in the number of molecules.

68) "At a fixed temperature, the greater the mass of a gas molecule the slower it moves." This is expressed in

- A) Charles' Law
- B) Boyle's Law
- \*C) Grahams's Law
- D) Dalton's Law

69) The system, liquid = vapour, is in equilibrium. The volume of the vapour is increased by increasing the size of the closed container. When the equilibrium is again restored (at the same temperature) the

- A) vapour pressure has been increased
- B) vapour pressure has been decreased
- C) concentration of vapour molecules has increased
- \*D) number of vapour molecules has increased

70) If the pressure exerted by a certain number of gas molecules remains constant while the temperature increases, the volume occupied by the gas

- A) remains constant
- \*B) steadily increases
- C) steadily decreases
- D) increases at first then sharply drops as the gas changes to a liquid

12A.4.

71) Which one of the following is a basic assumption of the kinetic molecular theory?

- \*A) Particles are in constant motion.
- B) Particles lose energy with an increase in velocity.
- C) Particles travel faster as the temperature decreases.
- D) Particles lose energy when the temperature increases.

72) What is the relative velocity of gaseous water ( $\text{H}_2\text{O}$ ) gas molecules compared to carbon dioxide ( $\text{CO}_2$ ) gas molecules

$\left( \frac{v_{\text{H}_2\text{O}}}{v_{\text{CO}_2}} \right)$  at the same temperature?

- A) 2.44
- B) 0.409
- \*C) 1.56
- D) 0.640

73) If a gas is cooled in a closed container, its molecules

- \*A) move more slowly
- B) move faster
- C) occupy a smaller volume
- D) have more collisions per unit time

74) Gases obey the Ideal Gas Laws most closely at

- A) high pressure and low temperature
- B) high pressure and high temperature
- \*C) low pressure and high temperature
- D) low pressure and low temperature

12A.4.

- 75) An empty glass flask (one with all the air pumped out) is found to have a mass of  $110.02 \pm 0.01$  g. When filled with oxygen gas ( $O_2(g)$ ) the flask is found to have a mass of  $110.66 \pm 0.01$  g. The volume of the flask is
- A) 0.224 L
  - \*B) 0.448 L
  - C) 0.896 L
  - D) 1.10 L
- 76) Gases are often collected in vessels by the downward displacement of water. The main advantage of this method is that
- A) it can be used for all gases
  - B) the gas is well moistened
  - \*C) the gas will not be mixed with air
  - D) water is inert
- 77) Which of the following statements about equal volumes of two different gases at the same temperature and pressure is generally true?
- A) They have different numbers of molecules.
  - B) They have the same mass.
  - \*C) They have the same number of molecules.
  - D) They have different  $P \times V$  values.
- 78) A cylinder contains 2.50 L of air at a pressure of 505 kPa. At what volume (temperature remaining constant) will the air exert a pressure of 101 kPa?
- A) 0.500 L
  - B) 2.00 L
  - C) 10.0 L
  - \*D) 12.5 L

12A.4.

- 79) Which of the following statements best accounts for the fact that gases can be easily compressed?
- A) Molecules occupy space.
  - B) The collisions of molecules are elastic.
  - C) Molecules of gases are in constant motion.
  - \*D) Molecules of gases are relatively far from each other.
- 80) If the pressure is kept constant the volume of a given mass of gas varies
- A) inversely with the Celsius temperature
  - \*B) directly with the absolute or Kelvin temperature
  - C) inversely with the absolute or Kelvin temperature
  - D) directly with all temperature units
- 81) At the same temperature the average kinetic energy of oxygen molecules relative to the average kinetic energy of hydrogen molecules
- A) is less
  - B) is greater
  - \*C) is the same
  - D) varies depending on the amount of gases
- 82) For any confined gas, when temperature is increased and volume is decreased at the same time the
- A) molecules move slower
  - B) average kinetic energy is decreased
  - C) number of collisions decreases
  - \*D) pressure increases

12A.4.

- 83) If the pressure on 300 mL of a gas at 293 K is doubled while the temperature remains constant at 293 K, the new volume will be
- \*A) 150 mL
  - B)  $\frac{273}{293} \times 300$  mL
  - C)  $\frac{293}{273} \times 300$  mL
  - D) 600 mL
- 84) A sample of gas in an open container is heated from 298 K to 323 K. The average kinetic energy of the molecules of the gas is increased by a factor of
- A)  $\frac{323}{273}$
  - \*B)  $\frac{323}{298}$
  - C)  $\frac{298}{323}$
  - D)  $\frac{298}{273}$
- 85) Which one of the following statements is true?
- A) Vapour pressure increases with temperature because the boiling point is higher.
  - B) Ether can be considered a non-volatile liquid.
  - \*C) Gases exert pressure due to molecular collisions with the walls of the container.
  - D) Molecules of different mass have different average kinetic energies at the same temperature.

12A.4.

- 86) At constant volume the pressure of a gas in a closed container increases with increasing temperature because
- \*A) the molecules of the gas move faster
  - B) the volume of molecules increases
  - C) the mass of the gas decreases
  - D) the mass of the gas increases
- 87) The random motion of gas molecules helps to explain
- A) the compressibility of gases
  - \*B) the fact that gases fill their container
  - C) the low density of gases
  - D) the transparency of gases
- 88) A gas is
- A) always clear and colourless
  - B) always odourless
  - C) not compressible
  - \*D) highly compressible
- 89) If the pressure of a gas is constant and the temperature increased, the density will
- A) remain steady
  - B) increase
  - \*C) decrease
  - D) will approach a maximum value

12A.4.

90) Which one of the following gases has the greatest average molecular velocity at 373 K?

- A) carbon dioxide ( $\text{CO}_2$ )
- B) oxygen ( $\text{O}_2$ )
- C) helium (He)
- \*D) hydrogen ( $\text{H}_2$ )

91) During boiling, the temperature of a pure liquid substance

- A) increases
- B) decreases
- C) decreases then increases
- \*D) remains the same

92) 5.00 L of dry oxygen ( $\text{O}_2$ ) are collected at 103 kPa and 300 K. The volume of the oxygen, at STP, is

- A)  $5.00 \times \frac{103}{101} \times \frac{300}{273} \text{ L}$
- \*B)  $5.00 \times \frac{103}{101} \times \frac{273}{300} \text{ L}$
- C)  $5.00 \times \frac{101}{103} \times \frac{300}{273} \text{ L}$
- D)  $5.00 \times \frac{103}{101} \times \frac{300}{273} \text{ L}$

93) If the temperature of a sample of gas is raised while the pressure remains constant, the density of the gas

- A) increases
- \*B) decreases
- C) stays the same
- D) stays the same until the gas finally condenses

12A.4.

94) If 25 g of hydrogen gas in a closed container is heated from 0°C to 273°C the mass of the gas at 273°C will be

A)  $25 \times \frac{1}{273} \text{ g}$

B)  $25 \times \frac{273}{546} \text{ g}$

\*C) 25 g

D)  $25 \times \frac{546}{273} \text{ g}$

95) Other factors being constant, the volume of an ideal gas is NOT affected by changes in the

A) number of molecules present

\*B) molar mass of the gas

C) temperature

D) pressure

96) At a fixed temperature and pressure the average distance between molecules would be greatest in a sample of

A) wood

\*B) air

C) sponge rubber

D) water

97) Molecular motion that occurs when the centre of mass of a molecule moves from one place to another is called

\*A) translational motion

B) rotational motion

C) vibrational motion

D) transversal motion

12A.4.

- 98) The volume of a confined gas can be reduced at constant temperature by increasing the pressure on the gas. The change in volume may best be explained by the fact that gas molecules
- A) take up space
  - B) are in constant motion
  - C) collide without loss of energy
  - \*D) are relatively far apart
- 99) On a winter day ice may change directly to vapour. Such a change is called
- A) evaporation
  - \*B) sublimation
  - C) condensation
  - D) fusion
- 100) During the slow melting of a pure substance, the temperature
- A) rises
  - \*B) stays constant
  - C) falls
  - D) changes suddenly
- 101) When a sample of a liquid changes to a gas the heat of
- \*A) vaporization is absorbed
  - B) fusion is absorbed
  - C) fusion is released
  - D) vaporization is released

12A.4.

102) The process of evaporation followed by condensation into a separate vessel is called

- A) vaporization
- \*B) distillation
- C) dehydration
- D) filtration

103) The state of matter characterized by a definite volume and a shape determined by the shape of the container is

- A) solid
- \*B) liquid
- C) gas
- D) vapour

104) The state of matter which exhibits definite volume but not definite shape is

- \*A) liquid
- B) gas
- C) solid
- D) fluid

105) The vapour pressure of pure water is a function of

- A) the surface area of the water
- B) the atmospheric pressure
- \*C) the temperature of the water
- D) the volume of the water

12A.4.

- 106) The vapour pressure of water at  $19^{\circ}\text{C}$  is 2.2 kPa. Some oxygen is collected over water at  $19^{\circ}\text{C}$  and the total measured pressure is 101.1 kPa. The pressure due to the oxygen is
- \*A) 98.9 kPa
  - B) 99.9 kPa
  - C) 101.1 kPa
  - D) 103.3 kPa
- 107) The instrument used to measure differences in gas pressure is called a
- A) barometer
  - B) calorimeter
  - \*C) manometer
  - D) dosimeter
- 108) Which of the following is a characteristic of a gas at STP?
- A) diffusion occurs slowly
  - B) compression is difficult
  - C) the material is malleable
  - \*D) the gas completely fills its container
- 109) An instrument used to measure gas pressure is a
- \*A) barometer
  - B) calorimeter
  - C) dosimeter
  - D) hygrometer

12A.4.

- 110) Equal masses of hydrogen and oxygen are placed in a sealed container. Which of the following statements about the system is TRUE
- A) since there are more hydrogen molecules, the mass of the hydrogen is the greater
  - B) since both the hydrogen and the oxygen are at the same temperature, both have the same average molecular velocity
  - C) since they are both at the same temperature, both exert the same pressure
  - \*D) since the oxygen molecule is 16 times heavier than the hydrogen molecule, the hydrogen molecules are, on the average, moving 4 times faster than the oxygen
- 111) A gaseous solution contains oxygen ( $O_2$ ) and nitrogen ( $N_2$ ). Relative to the nitrogen molecules, the oxygen molecules have, on the average,
- A) the same mass
  - \*B) the same kinetic energy
  - C) the same number of electrons
  - D) the same velocity
- 112) A sample of gas in an open container is heated from  $25^{\circ}C$  to  $50^{\circ}C$ . The average kinetic energy of the molecules of the gas is now
- A)  $\frac{298}{323}$  times that at  $25^{\circ}C$
  - \*B)  $\frac{323}{298}$  times that at  $25^{\circ}C$
  - C)  $\frac{50}{25}$  times that at  $25^{\circ}C$
  - D)  $\frac{25}{50}$  times that at  $25^{\circ}C$

12A.4.

- 113) Gas A is 9.0 times as dense as gas B.  
Gas B diffuses at a rate of 12 cm/s.  
Gas A will diffuse at a rate of
- A) 1.0 cm<sup>3</sup>/s
  - B) 2.0 cm<sup>3</sup>/s
  - C) 3.0 cm<sup>3</sup>/s
  - \*D) 4.0 cm<sup>3</sup>/s
- 114) Gases A and B are at the same temperature but gas A molecules are 4 times heavier than gas B molecules. The ratio of velocities of molecules of gas A to those of gas B is
- A) 4:1
  - B) 2:1
  - \*C) 1:2
  - D) 1:4
- 115) The temperature of a sample of oxygen gas in a sealed glass container is increased. It follows that the
- A) density of the gas increased
  - B) density of the gas decreased
  - \*C) average molecular velocity of the gas increased
  - D) average molecular velocity of the gas decreased
- 116) If 2 containers of ideal gases under the same conditions of temperature and pressure have the same number of molecules, the gas samples must also
- A) be of the same substance
  - B) have the same numbers of atoms
  - C) have the same mass
  - \*D) have the same volume

12A.4.

117) When both hydrogen and oxygen gases are measured at STP, 1.00 L of oxygen contains the same number of molecules as

- \*A) 1.00 L of hydrogen
- B) 16.0 L of hydrogen
- C) 32.0 L of hydrogen
- D) 22.4 L of hydrogen

118) The number of molecules in a litre of oxygen at S.T.P. is

- \*A) the same as the number of molecules in a litre of hydrogen at S.T.P.
- B) 16 times as many as the number of molecules in a litre of hydrogen at S.T.P.
- C)  $\frac{1}{16}$  as many as the number of molecules in a litre of hydrogen at S.T.P.
- D)  $\frac{1}{4}$  as many as the number of molecules in a litre of hydrogen at S.T.P.

119) Avogadro's principle states that equal volumes of all gases at the same temperature and pressure

- \*A) contain the same number of molecules
- B) contain the same number of atoms
- C) contain the same number of ions
- D) contain the same number of elements

120) Boyle's Law concerns the

- \*A) pressure and volume of gases (number of molecules and temperature constant)
- B) partial pressure of gases (temperature and volume constant)
- C) temperature and volume of gases (number of molecules and pressure constant)
- D) temperature and pressure of gases (number of molecules and volume constant)

12A.4.

121) Boyle's Law can be expressed by the relation

- A)  $V_1 T_2 = V_2 T_1$
- B)  $V_1 T_1 = V_2 T_2$
- \*C)  $P_1 V_1 = P_2 V_2$
- D)  $P_1 V_2 = P_2 V_1$

122) At constant pressure, the volume of a given mass of an ideal gas varies

- \*A) directly with the Kelvin temperature
- B) directly with the Celsius temperature
- C) inversely with the Celsius temperature
- D) inversely with the Kelvin temperature

123) To change a temperature reading from the Kelvin scale to the Celsius scale

- A) add 273
- B) multiply by  $\frac{273}{100}$
- C) multiply by  $\frac{100}{273}$
- \*D) subtract 273

124) If the pressure on 300 mL of an ideal gas is doubled while the temperature remains constant at 20°C, the new volume will be

- \*A)  $300 \times \frac{1}{2}$  mL
- B)  $\frac{273}{293} \times 300$  mL
- C)  $\frac{293}{273} \times 300$  mL
- D)  $300 \times \frac{2}{1}$  mL

12A.4.

- 125) A 300 mL sample of an ideal gas at 27°C and 100 kPa pressure is subjected to changes in pressure and temperature. The pressure is doubled and the temperature is changed to 400 K. The new volume will be

A)  $300 \times \frac{27}{400} \times \frac{200}{100}$  mL

B)  $300 \times \frac{400}{27} \times \frac{100}{200}$  mL

C)  $300 \times \frac{300}{400} \times \frac{200}{100}$  mL

\*D)  $300 \times \frac{400}{300} \times \frac{100}{200}$  mL

- 126) If the pressure exerted on an elastic container of gas remains constant while the temperature decreases, then the volume occupied by the gas

A) remains unchanged

B) increases

C) cannot be predicted

\*D) decreases

- 127) An automobile tire contains air at a pressure of 200 kPa and 25°C. After travelling, the tire and the air in the tire heated up and the pressure increased to 250 kPa. Provided the tire does not expand and the air behaves as an ideal gas, the temperature of the air, on the Kelvin scale, inside the tire can be expressed by

\*A)  $\frac{250 \times 298}{200}$

B)  $\frac{250 \times 298}{100}$

C)  $\frac{250}{200 \times 298}$

D)  $\frac{100 \times 25}{200}$

- 128) If the temperature of a fixed mass of gas is kept constant while the volume is decreased
- A) the number of collisions decreases
  - \*B) the number of collisions increases
  - C) the average kinetic energy of the particles increases
  - D) the average kinetic energy of the particles decreases
- 129) 100 mL of an ideal gas initially at  $27^{\circ}\text{C}$  is heated to  $270^{\circ}\text{C}$  at constant pressure. The new volume will be
- A) 55 mL
  - \*B) 181 mL
  - C) 550 mL
  - D) 1000 mL
- 130) An ideal gas in a rigid container exerts a pressure of  $1.01 \times 10^2$  kPa at  $10.0^{\circ}\text{C}$ . The temperature is increased to  $100^{\circ}\text{C}$ . The new pressure in the container will be
- A)  $7.66 \times 10^1$  kPa
  - B)  $1.01 \times 10^2$  kPa
  - \*C)  $1.33 \times 10^2$  kPa
  - D)  $1.01 \times 10^3$  kPa
- 131) 2.00 L of dry hydrogen gas is collected at 100 kPa pressure and  $27.0^{\circ}\text{C}$ . The volume of this hydrogen measured at  $227^{\circ}\text{C}$  and 220 kPa pressure would be
- A)  $2.00 \times \frac{220}{100} \times \frac{27}{227}$  L
  - B)  $2.00 \times \frac{100}{220} \times \frac{300}{500}$  L
  - C)  $2.00 \times \frac{220}{100} \times \frac{300}{500}$  L
  - \*D)  $2.00 \times \frac{100}{220} \times \frac{500}{300}$  L

12A.4.

132) Equal masses of hydrogen and oxygen are placed in a container and the container is tightly stoppered. Which of the following statements is true about the system?

- \*A) There are more hydrogen molecules than oxygen molecules.
- B) All of the molecules have the same velocity.
- C) Both gases exert the same pressure on the walls of the container.
- D) All of the molecules strike the walls with the same force

133) If the temperature of an ideal gas is raised while the pressure exerted on the gas is kept constant, the density of the gas

- A) will increase
- \*B) will decrease
- C) will remain the same
- D) cannot be predicted

134) When the pressure on 1.0 L of gas is doubled and the temperature on the Kelvin scale is tripled, the volume becomes

- A)  $\frac{2}{3}$  L
- \*B)  $\frac{3}{2}$  L
- C) 6 L
- D)  $\frac{1}{6}$  L

12A.4.

135) Charles' law can be expressed by the relation

\*A)  $V_2 T_1 = V_1 T_2$

B)  $V_1 V_2 = T_1 T_2$

C)  $V_1 T_1 = V_2 T_2$

D)  $V_1 T_2 = \frac{V_2}{T_1}$

136) The density of  $O_2$  (oxygen) gas at STP is 1.43 g/L. What would its density be at 373 K and 98.1 kPa?

\*A) 1.02 g/L

B) 1.46 g/L

C) 1.89 g/L

D) 2.02 g/L

12A.5.

- 1) An example of an endothermic reaction is
  - A) the burning of Mg (magnesium)
  - \*B) the decomposition of  $\text{KClO}_3$  (potassium chlorate)
  - C) the union of  $\text{O}_2$  (oxygen) and  $\text{H}_2$  (hydrogen)
  - D) the burning of  $\text{CH}_4$  (methane)
  
- 2) A chemical reaction is always accompanied by
  - A) the release of energy
  - B) no change in energy
  - C) the absorption of energy
  - \*D) an energy change
  
- 3) An agent which affects a chemical action without itself being permanently altered is a
  - A) precipitate
  - B) chemical element
  - \*C) catalyst
  - D) compound
  
- 4) Oxygen occurs as
  - A) ninety-nine percent by mass of water
  - \*B)  $1/5$  by volume of air
  - C) almost  $4/5$  by mass of the human body
  - D) a solid at room temperature
  
- 5) Oxygen is usually made commercially from
  - A) mercury(II) oxide
  - B) potassium chlorate
  - \*C) liquid air
  - D) ozone

12A.5.

- 6) Which one of the processes listed below most effectively reduces the carbon dioxide content of the air?
- A) respiration
  - B) decay
  - \*C) photosynthesis
  - D) combustion
- 7)  $\text{MnO}_2$  (manganese dioxide) is added to  $\text{KClO}_3$  (potassium chlorate) in the preparation of oxygen in order to
- A) increase the total amount of oxygen produced
  - \*B) bring about decomposition at a different rate
  - C) decrease the danger of an explosive reaction
  - D) act as an oxidizing agent
- 8) Air can be converted into a liquid most readily by
- A) cooling it and reducing its pressure
  - B) warming it and increasing its pressure
  - \*C) cooling it and increasing its pressure
  - D) increasing its temperature and its pressure
- 9) In the commercial preparation of oxygen, the oxygen is separated from nitrogen by a procedure which depends upon the fact that
- A) oxygen is chemically more active than nitrogen
  - \*B) nitrogen has a lower boiling point than oxygen
  - C) nitrogen is cooled more quickly than oxygen
  - D) liquid oxygen is denser than liquid nitrogen

12A.5.

10) Oxygen is made commercially by the distillation of liquid air. Liquid air consists of  $O_2$  (oxygen),  $N_2$  (nitrogen) and some argon (Ar). The boiling point of  $O_2$  is 90 K, the boiling point of  $N_2$  is 77 K and the boiling point of Ar is 88 K. When liquid air is distilled the gas that distills off first is

- A)  $O_2$
- \*B)  $N_2$
- C) Ar
- D) NO

11) When sodium burns in air the formula of the oxide formed is

- A) NaO
- B)  $Na_2O_3$
- \*C)  $Na_2O$
- D)  $NaO_2$

12) At room temperature and pressure, sulfur dioxide is a

- A) clear, colourless, odourless gas
- B) clear, yellow, odourless gas
- \*C) clear, colourless, strong smelling gas
- D) violet smoke

13) When a candle has burned for some time the wax becomes less massive because it

- A) melted to a liquid
- B) undergoes changes in density
- C) changes to carbon and hydrogen
- \*D) reacts to form water vapour and carbon dioxide

12A.5.

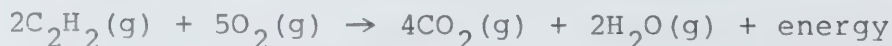
14) Which of the following must be present in order for iron to rust at normal room temperatures?

- A) oxygen only
- B) water and nitrogen
- \*C) oxygen and water
- D) water only

15) If  $\text{XBr}_2$  is the formula for a metallic bromide, the formula for the oxide of metal X is

- A)  $\text{X}_2\text{O}$
- \*B)  $\text{XO}$
- C)  $\text{X}_2\text{O}_3$
- D)  $\text{XO}_2$

16) The complete combustion of  $\text{C}_2\text{H}_2$  (acetylene) is represented by the following balanced chemical equation:



Which of the following statements is in agreement with the equation?

- A) The reaction is endothermic.
- B) Measured at the same temperature and pressure, the products occupy a greater volume than the reactants.
- C) 2.0 g of  $\text{C}_2\text{H}_2$  react with 5.0 g of  $\text{O}_2$ .
- \*D) The number of molecules is not conserved in the reaction.

17) When iron (steel wool) is burned in oxygen, the product

- A) has a choking odour
- B) is a white smoke
- \*C) is magnetic
- D) is soluble in water

12A.5.

18) When carbon (charcoal) burns completely in air

- A) a brilliant white light is given off
- \*B) a colourless gas is produced
- C) a water insoluble product results
- D) the reaction is endothermic

19) When organic compounds such as  $\text{CH}_3\text{OH}$  (methanol) and  $\text{C}_3\text{H}_8$  (propane) undergo complete combustion in air, the substances produced have the formulae

- A)  $\text{CO}$  and  $\text{H}_2\text{O}$
- \*B)  $\text{H}_2\text{O}$  and  $\text{CO}_2$
- C)  $\text{CO}_2$  and  $\text{H}_2\text{O}_2$
- D)  $\text{C}_2\text{O}$  and  $\text{H}_2$

20) When carbon burns in excess  $\text{O}_2$  (oxygen) the product of combustion has the formula

- A)  $\text{C}_2\text{O}$
- B)  $\text{CO}_3$
- \*C)  $\text{CO}_2$
- D)  $\text{C}_3\text{O}$

21) Which one of the following groups of elements will all produce acidic solutions when their oxides are dissolved in water?

- \*A) Cl    S    Br    N
- B) S    P    Ca    Na
- C) N    Mg    K    Ni
- D) Li    Mg    Na    Cu

12A.5.

- 22) A certain element forms a solid oxide which dissolves in water to produce a solution which turns litmus paper from blue to red. The element is a(n)
- A) gas
  - B) metal
  - C) anhydride
  - \*D) non-metal
- 23) An element whose oxide will react with water to form a basic solution is
- \*A) Mg
  - B) Cl
  - C) P
  - D) S
- 24) According to the Phlogiston Theory a candle, during combustion,
- A) increases in mass
  - B) absorbs phlogiston
  - \*C) loses phlogiston
  - D) reacts with oxygen
- 25) Hydrogen is
- A) less dense than air and inert
  - B) very soluble in water and combustible
  - \*C) odourless and combustible
  - D) denser than air and tasteless

12A.5.

- 26) Potassium reacts with excess water according to the equation:



In the balanced equation, X represents

- A)  $\text{K}_2\text{O}$
  - B)  $2\text{O}_2$
  - \*C)  $2\text{KOH}$
  - D)  $\text{KOH}$
- 27) A metal which does NOT readily liberate  $\text{H}_2$  (hydrogen) from cold water is
- \*A) magnesium
  - B) sodium
  - C) potassium
  - D) calcium
- 28)  $\text{H}_2$  (hydrogen) will be formed most readily when steam reacts with hot
- \*A) iron
  - B) gold
  - C) copper
  - D) silver
- 29) A mixture consisting of 10 mL of  $\text{H}_2$  (hydrogen gas) and 10 mL of  $\text{O}_2$  (oxygen gas) is exploded in a eudiometer tube. The gas remaining in the eudiometer contains
- A) 5.0 mL of hydrogen
  - \*B) 5.0 mL of oxygen
  - C) 10.0 mL of a hydrogen-oxygen mixture
  - D) 15 mL of water vapour

12A.5.

30) A mixture of  $H_2$  (hydrogen) and  $O_2$  (oxygen) was exploded by an electric spark. The identity of any residual gas depends on

- A) the rate of reaction
- \*B) which gas is in excess
- C) the volume of the container
- D) the pressure

31) In the Dumas experiment, dry  $H_2(g)$  (hydrogen gas) is allowed to react with heated  $CuO$  (copper(II) oxide). The products of this reaction are

- A)  $Cu$  and  $O_2$
- B)  $H_2$  and  $Cu$
- \*C)  $Cu$  and  $H_2O$
- D)  $CuH$  and  $O_2$

32) When passed over hot  $CuO$  (copper(II) oxide),  $H_2$  (hydrogen) acts as a(n)

- A) catalyst
- B) solute
- \*C) reducing agent
- D) oxidizing agent

33) When a metal is added to  $HCl$  (hydrochloric acid)

- \*A)  $H_2$  (hydrogen) may be produced
- B)  $O_2$  (oxygen) may be produced
- C)  $H_2$  and  $O_2$  may be produced together
- D)  $Cl_2$  (chlorine) may be produced

12A.5.

- 34) Which of the following statements about the activity series is true?
- \*A) A metal will be displaced from a solution of one of its compounds by any metal that is higher in the activity series.
  - B) The lower a metal is in the series, the more easily it will form an oxide.
  - C) Iron and all metals above it will displace oxygen from cold water.
  - D) The most active metals are at the bottom of the series.
- 35) Which of the following is most correct?
- A) Metals are good oxidizing agents.
  - B) Metals react by gaining electrons.
  - C) Metals react with metals below them on the activity series.
  - \*D) Metals react with the ions of metals below them on the activity series.
- 36) Elements most commonly found in the 'native' state are those
- A) near the top of the activity series
  - B) in the middle of the activity series
  - C) below iron in the activity series
  - \*D) below hydrogen in the activity series
- 37) Which of the following is most correct?
- A) Metals are good oxidizing agents.
  - B) Metals react by gaining electrons.
  - C) Metals react with metals below them on the activity series.
  - \*D) Metals react with the ions of metals below them on the activity series.

12A.5.

- 38)  $\text{H}_2$  (hydrogen) reacts with hot  $\text{CuO}$  (copper(II) oxide) according to the following equation:



The substance that becomes oxidized is

- A) copper(II) oxide
  - B) copper
  - C) water
  - \*D) hydrogen
- 39) One example of an oxide that reacts with water to form a basic solution is
- A)  $\text{SO}_2$  (sulfur dioxide)
  - B)  $\text{CO}_2$  (carbon dioxide)
  - C)  $\text{P}_4\text{O}_{10}$  (phosphorus(V) oxide)
  - \*D)  $\text{CaO}$  (calcium oxide)
- 40) If alcohol is burned in air and the products of combustion are passed through limewater, a white precipitate is produced. This result provides evidence that one of the constituent elements of the alcohol is
- \*A) carbon
  - B) chlorine
  - C) hydrogen
  - D) oxygen
- 41) Oxygen is obtained commercially from liquid air by the process of
- A) cracking
  - B) electrolysis
  - \*C) fractional distillation
  - D) polymerization

12A.5.

42) When  $H_2$  (hydrogen) burns in air the product formed is

- A) an acid anhydride
- B) a basic anhydride
- \*C) water
- D) an oxidizer

43) When magnesium is burned in a closed crucible with a lid which is lifted slightly from time to time to admit air, there is an increase in the mass of the contents of the crucible. When magnesium is burned in an open crucible there is a loss in the mass of the contents. The reason for the different result is that

- \*A) oxide smoke is not lost in the first experiment
- B) a compound is formed in the first experiment but decomposition occurs in the second
- C) different oxides are formed in the two different experiments
- D) magnesium oxide is formed in a plentiful supply of air while magnesium nitride is formed in a limited supply of air

44) The most abundant element in the universe is

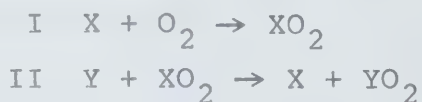
- \*A) hydrogen
- B) carbon
- C) oxygen
- D) silicon

12A.5.

45) Which one of the following statements about chemical reactions is true?

- A) The mass of the products formed can be greater than than the mass of the reactants.
- B) The number of moles of reactants always equals the number of moles of products.
- \*C) The reaction may produce new molecules through the rearrangement of atoms.
- D) The number of molecules of reactants always equals the number of molecules of products.

46) Three different substances, X, Y and oxygen, are mixed. A two-step reaction occurs



Which substance acts as a catalyst in the set of reactions?

- A)  $\text{O}_2$
- B)  $\text{XO}_2$
- C) Y
- \*D) X

47) The oxides of metals, when dissolved in water, generally form

- A) acids
- B) anhydrides
- \*C) bases
- D) salts

12A.5.

48) Which of the following elements will displace hydrogen most readily from a hydrochloric acid solution?

- A) mercury
- B) silver
- \*C) aluminum
- D) copper

49) When oxygen reacts with the food we eat, the processes that occur are

- A) endothermic reactions
- \*B) exothermic reactions
- C) neutralization reactions
- D) combustion reactions

12A.5.

- 50) When lycopodium powder is heated in a spoon it burns slowly with a yellow, sooty flame, yet when it is blown through a Bunsen burner flame it burns explosively. An explanation of this observation is that
- \*A) the exposed surface area of the powder is much larger in the burner flame than in the spoon
  - B) the concentration of oxygen in the burner flame is higher than it was above the spoon
  - C) the lycopodium powder reacts with the burner gas
  - D) the burner gas acts as a catalyst to the reaction
- 51) A substance which changes the rate of a chemical reaction without being permanently altered is
- A) an oxidizing agent
  - \*B) a catalyst
  - C) a reducing agent
  - D) an electrolyte
- 52) Chemical change is always accompanied by a(n)
- A) liberation of heat
  - B) absorption of heat
  - C) colour change
  - \*D) energy change
- 53) A chemical reaction is termed exothermic if
- A) the reaction absorbs energy
  - B) the reaction requires energy to initiate the reaction
  - C) the temperature at which the reaction occurs is high
  - \*D) energy is liberated during the reaction

12A.5.

54) An example of an endothermic process is

- A) condensing a sample of steam
- \*B) melting a sample of ice
- C) burning a sample of charcoal
- D) freezing a sample of water

55) "The total mass of reactants equals the total mass of products" is a statement of the

- A) law of definite proportions
- B) law of multiple proportions
- C) law of conservation of energy
- \*D) law of conservation of mass

56) Oxygen can be readily identified by

- A) its odour
- \*B) its effect on a glowing splint
- C) its effect on limewater
- D) its effect on bromthymol blue

57) A burning splint is thrust into a bottle of gas. If the bottle contains oxygen

- A) the splint is extinguished immediately
- B) there is a small explosion and the splint is extinguished
- \*C) the splint burns more brightly
- D) the splint burns in the same way it did in air

12A.5.

58) When oxygen is prepared in the laboratory, it is collected by the downward displacement of water because

- A) it is a colourless gas
- \*B) it is sparingly soluble in water
- C) it is poisonous in large amounts
- D) it is less dense than air

59) Pure oxygen gas can be obtained by

- A) boiling water
- \*B) heating potassium chlorate
- C) heating potassium chloride
- D) heating manganese dioxide

60) Oxygen is usually prepared commercially from

- A) mercury(II) oxide
- B) potassium chlorate
- C) manganese dioxide
- \*D) liquid air

61) Which of the following substances, when heated strongly in air, will cause an increase in sample mass?

- A) platinum
- \*B) iron
- C) mercuric oxide
- D) potassium chlorate





12A.5.

62) Two products formed by burning a wax candle in air are water and carbon dioxide. The original candle must have contained at least

- A) carbon and oxygen
- B) hydrogen and oxygen
- \*C) carbon and hydrogen
- D) carbon dioxide and oxygen

63) The presence of carbon dioxide can be detected by mixing it with

- \*A) limewater
- B) limestone
- C) quicklime
- D) slaked lime

64) Which of the following equations represents the complete combustion of acetylene ( $C_2H_2$ )?

- A)  $2C_2H_2(g) + O_2(g) \rightarrow 4C(s) + H_2O(g)$
- B)  $2C_2H_2(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g) + 2C(s)$
- C)  $2C_2H(g) + 2O_2(g) \rightarrow 2CO_2(g) + 2H_2(g) + 2C(s)$
- \*D)  $2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g)$

65) An example of a substance with a low ignition temperature is

- A) coal
- B) iron
- C) water
- \*D) phosphorus

12A.5.

66) When metals are burned in oxygen, the products are most often

- A) bases
- B) acids
- C) acidic oxides
- \*D) basic oxides

67) The oxides of metals, when dissolved in water, generally form

- A) acids
- \*B) bases
- C) acidic oxides
- D) basic oxides

68) At room temperature and pressure phosphorus(V) oxide (phosphorus pentoxide) is

- A) a gas
- B) a yellow solid
- C) a colourless liquid
- \*D) a white solid

69) The most abundant element in the earth's crust is

- A) nitrogen
- B) oxygen
- \*C) silicon
- D) carbon

70) When active metals react with water they produce

- \*A) bases and hydrogen gas
- B) acids and hydrogen gas
- C) carbon dioxide gas
- D) salts and carbon dioxide gas

12A.5.

71) Natural gas is chiefly composed of

- A) carbon monoxide
- B) hydrogen
- \*C) methane
- D) carbon dioxide

72) Hydrogen is gaseous except at very low temperatures because

- A) hydrogen molecules have little mass
- B) of weak bonds between atoms in the hydrogen molecules
- \*C) of weak forces between neighbouring molecules
- D) hydrogen molecules are very small

73) Hydrogen is both

- A) inert and less dense than air
- \*B) odourless and flammable
- C) flammable and more dense than air
- D) colourless and more dense than air

74) Which metal is usually stored under kerosene?

- A) mercury
- \*B) sodium
- C) zinc
- D) silver

12A.5.

- 75) If a piece of zinc metal is placed in a beaker of dilute hydrochloric acid, which of the following will occur?
- A) a vigorous reaction, accompanied by the evolution of chlorine
  - \*B) a vigorous reaction, accompanied by the evolution of hydrogen
  - C) no visible reaction
  - D) reaction of the metal without the evolution of gas
- 76) In order to minimize oxidation of potassium metal it is best to store the potassium
- A) under water
  - \*B) under paraffin oil
  - C) in metal containers
  - D) in refrigerators
- 77) Which of the following oxides reacts with water to form a base?
- A)  $\text{SO}_2$
  - B)  $\text{CO}_2$
  - C)  $\text{P}_4\text{O}_{10}$
  - \*D)  $\text{CaO}$
- 78) Which of the following reacts with water to form a base?
- \*A) magnesium oxide
  - B) sulphur dioxide
  - C) carbon dioxide
  - D) phosphorus(V) oxide

12A.5.

79) Which of the following CANNOT be used, by itself, as a source of oxygen in the laboratory?

- A)  $\text{KMnO}_4$
- B)  $\text{KClO}_3$
- \*C)  $\text{SCO}_2$
- D)  $\text{KNO}_3$

80) The decomposition of mercury(II) oxide by heating can lead to the formation of

- \*A) mercury and oxygen
- B) mercury and nitrogen
- C) mercury(IV) oxide
- D) hydrogen and oxygen

81) A given element that burns readily in air to form an oxide in which the ratio of O atoms to atoms of the given element is 1:1 is

- \*A) Mg
- B) V
- C) Si
- D) Cs

82) When magnesium is burned in air and water is added to the product, the compound formed is

- A)  $\text{MgO}$
- B)  $\text{Mg(OH)}$
- \*C)  $\text{Mg(OH)}_2$
- D)  $\text{Mg}_2(\text{OH})_3$

12A.5.

83) In a laboratory preparation of  $O_2$  (oxygen),  $MnO_2$  (manganese dioxide) is used as a(n)

- \*A) catalyst
- B) oxidizing agent
- C) flux
- D) reducing agent

84) Which one of the following oxides reacts with water to form a base?

- A)  $SO_2$  (sulfur dioxide)
- B)  $CO_2$  (carbon dioxide)
- C)  $P_4O_6$  (phosphorus(III) oxide)
- \*D)  $MgO$  (magnesium oxide)

85) Aqueous hydrogen ion, in solution, may be detected by

- A) a bitter taste
- B) litmus paper turning blue
- C) a soapy texture
- \*D) reaction with magnesium ribbon

86) The volume of uncombined gas remaining after exploding a mixture of 16 mL of hydrogen gas and 4 mL of oxygen gas in eudiometer is

- A) 0 mL
- B) 4 mL
- \*C) 8 mL
- D) 12 mL

12A.5.

87) An example of an endothermic reaction is

- A) burning Mg (magnesium) in air
- \*B) decomposition of  $\text{KClO}_3$  (potassium chlorate)
- C) reaction of Na (sodium) with  $\text{H}_2\text{O}$  (water)
- D) reaction of C (carbon) with  $\text{O}_2$  (oxygen)

88) The substance that is produced when a non-metallic oxide reacts with water is a(n)

- A) metallic oxide
- \*B) acid
- C) base
- D) basic anhydride

89) A gas may be identified as oxygen by means of

- A) its colour and odour
- B) a litmus test
- C) its flammability
- \*D) a glowing splint test

90) Dilute sulphuric acid reacts with metals that are

- A) found near the bottom of the activity table
- B) less active than copper
- \*C) more active than hydrogen
- D) less active than hydrogen

12A.5.

91) An element whose oxide will react with water to form an acidic solution is

- A) Ca
- B) Na
- C) Ne
- \*D) P

92) Sulfur dioxide is a compound that

- A) is a liquid at room temperature and pressure
- \*B) is formed by burning sulfur in oxygen
- C) is a cloudy yellow gas at room temperature and pressure
- D) is formed only in the presence of a platinum catalyst

93) The presence of hydrogen gas can be demonstrated by

- A) its colour and odour
- B) a litmus test
- \*C) a burning splint test
- D) a glowing splint test

94) Collection of gas by downward displacement of water **cannot** be used for gases which are

- A) colourless
- \*B) very soluble in water
- C) coloured
- D) not appreciably soluble in water

12A.5.

95) When copper(II) oxide is heated in a stream of hydrogen it

- A) produces oxygen
- \*B) produces copper
- C) is oxidized
- D) undergoes no reaction

96) The first step in the process of spontaneous combustion is

- A) an active burning
- B) accumulation of heat
- \*C) slow oxidation
- D) ignition

97) Chemical processes are termed exothermic if they

- A) absorb energy from the surroundings
- \*B) liberate energy to the surroundings
- C) involve a colour change
- D) produce a final temperature above the boiling point of water

98) Oxygen gas is most often identified by its

- A) sweet odour and colour
- B) effect on bromthymol blue indicator
- C) effect on limewater
- \*D) effect on a glowing splinter of wood

99) The oxides of most metals are

- A) liquids
- \*B) basic anhydrides
- C) composed of molecules
- D) gases

12A.5.

100) Which one of the following metals will most readily displace hydrogen from water?

- A) aluminum
- B) iron
- C) magnesium
- \*D) calcium

12A.6.

- 1) If two containers of different ideal gases at the same temperature and pressure have the same number of molecules, the gases must have the same

A) molecular masses  
\*B) volumes  
C) masses  
D) densities

- 2) The number of moles of nitrogen molecules in 56.0 g of  $\text{N}_2(\text{g})$  is

A) 11.2  
\*B) 2.00  
C) 22.4  
D) 4.00

- 3) The following data were obtained in an electrochemical reaction:

Mass of cadmium strip before reaction	15.27 g
Mass of cadmium strip after reaction	13.02 g
Mass of silver formed	4.32 g

The relative atomic masses of Ag and Cd are 107.9 and 112.4 respectively. How many moles of silver were formed in the reaction?

A) 0.0100 mol  
B) 0.0200 mol  
C) 2.00 mol  
\*D) 0.0400 mol

12A.6.

4) The number of moles of  $\text{CO}_2$  (carbon dioxide) in 0.66 g of the gas is

- \*A) 0.015 mol
- B) 0.12 mol
- C) 0.44 mol
- D) 2.2 mol

5) The following data were obtained in an electrochemical experiment:

Mass of cadmium strip before reaction	15.27 g
Mass of cadmium strip after reaction	13.02 g

The relative atomic mass of Cd is 112.4 The number of moles of cadmium involved in the reaction were

- A) 1.0 mol
- \*B) 0.020 mol
- C) 0.12 mol
- D) 2.25 mol

6) The number of molecules in 2.0 mol of carbon dioxide ( $\text{CO}_2$ ) is

- A)  $1.8 \times 10^{24}$
- B)  $6.0 \times 10^{23}$
- \*C)  $1.2 \times 10^{24}$
- D)  $3.6 \times 10^{24}$

7) The number of moles of  $\text{N}_2$  (nitrogen gas) present in 21 g of the gas is

- A) 0.67
- \*B) 0.75
- C) 1.3
- D) 1.5

12A.6.

- 8) The number of moles of He (helium) in 100 g of helium is
- A) 12.5
  - \*B) 25.0
  - C) 50.0
  - D) 100
- 9) How many moles are there in  $6.72 \times 10^{-3} \text{ m}^3$  of  $\text{O}_2$  (oxygen) measured at STP conditions?
- A) 0.210
  - \*B) 0.300
  - C) 3.00
  - D) 6.72
- 10) The molar mass of Mg (magnesium) is 24 g. One atom of magnesium has a mass of
- A)  $2 \times 10^{-23} \text{ g}$
  - \*B)  $4 \times 10^{-23} \text{ g}$
  - C)  $10^{23} \text{ g}$
  - D)  $6 \times 10^{23} \text{ g}$
- 11) How many moles of oxygen gas ( $\text{O}_2$ ) are present in 0.64 g of oxygen gas?
- A) 0.010
  - \*B) 0.020
  - C) 0.080
  - D) 0.040

12A.6.

12) The relative molecular mass of  $C_{27}H_{46}O$  (cholesterol) is

- A) 77.0
- B) 116
- C) 346
- \*D) 386

13) The relative molecular mass of  $(NH_4)_2SO_4$  (ammonium sulfate) is

- A) 61.0
- B) 114
- C) 118
- \*D) 132

15) The mass of oxygen in 3.0 mol of  $O_2$  gas is

- A) 32 g
- B) 48 g
- C) 64 g
- \*D) 96 g

16) Chlorine is said to have a mass of 71 g/mol. This is classified as the

- A) molecular mass
- \*B) molar mass
- C) atomic mass
- D) molar volume

18) The mass of 4.00 mol of chlorine molecules ( $Cl_2$ ) is

- A)  $6.00 \times 35.5$  g
- B)  $2.00 \times 35.5$  g
- \*C)  $8.00 \times 35.5$  g
- D)  $4.00 \times 35.5$  g

12A.6.

19) How many moles of  $\text{SO}_2$  molecules are contained in 1.28 g of  $\text{SO}_2$ ?

- A) 0.00200 mol
- B) 0.00500 mol
- C) 0.0100 mol
- \*D) 0.0200 mol

20) The mass of  $6.02 \times 10^{23}$  atoms of  $\text{F}_2$  (fluorine) is

- A) 1.9 g
- B) 3.8 g
- \*C) 19 g
- D) 38 g

21) The sample of a gas which contains the same number of molecules as 44 g of  $\text{CO}_2$  (carbon dioxide) gas is

- A) 1.0 g of  $\text{H}_2$  (hydrogen)
- B) 16 g of  $\text{O}_2$  (oxygen)
- \*C) 34 g of  $\text{H}_2\text{S}$  (hydrogen sulfide)
- D) 44 g of  $\text{SO}_2$  (sulfur dioxide)

22) The statement: "the number of molecules in equal volumes of different gases is the same provided the volumes are measured at the same temperature and pressure", is referred to as

- A) Gay-Lussac's Law of Combining Gas Volumes
- B) the Law of Constant Composition
- C) Boyle's Law
- \*D) Avogadro's Principle

12A.6.

23) An empty flask (one with all air pumped out) is found to have a mass of  $110.02 \pm 0.01$  g. When filled with  $O_2(g)$  (oxygen gas) the flask is found to have a mass of  $110.66 \pm 0.01$  g. When filled with an unknown gas the flask is found to have a mass of  $110.38 \pm 0.01$  g. Which one of the following formulae could be that of the unknown gas?

\*A)  $H_2O$

B)  $H_2$

C) He

D)  $He_2$

24) The number of molecules of  $O_2$  (oxygen) in 1.0 L of  $O_2$  at 101 kPa and  $273^\circ C$  is

A)  $6.02 \times 10^{23}$

B)  $\frac{6.02 \times 10^{23}}{22.4}$

\*C)  $\frac{6.02 \times 10^{23}}{22.4} \times \frac{273}{546}$

D)  $\frac{6.02 \times 10^{23}}{22.4} \times \frac{546}{273}$

25) 2 L of HCl (hydrogen chloride gas) are produced in a chemical reaction which uses up 1 L of  $H_2$  (hydrogen) as one of the reactants. One may conclude that

A) one gram of  $H_2$  is responsible for producing two grams of HCl

\*B) one molecule of  $H_2$  is used up in forming two molecules of HCl

C) the numbers of molecules of  $H_2$  and HCl are the same

D) there are more molecules of  $H_2$  consumed than of HCl produced in the reaction

12A.6.

26) Which of the following statements are correct?

- I The relative atomic mass of an element is numerically equal to the mass of Avogadro's Number of atoms of the element.
  - II The relative molecular mass is always equal to twice the relative atomic mass.
  - III The density of a gas has no relationship to its molecular mass.
  - IV "22.4 L" is called the "molar" volume.
- A) I and II
  - \*B) I and IV
  - C) II and III
  - D) II and IV

27) A mole of any ideal gas

- A) always occupies 1.0 L
- B) always occupies 22.4 L
- C) can occupy any volume at STP
- \*D) always occupies 22.4 L at STP

28) The volume, at STP, of 10.0 g of fluorine gas ( $F_2$ ) is approximately

- A) 1.70 L
- \*B) 5.89 L
- C) 6.10 L
- D) 11.8 L

29) One mole of molecules of an ideal gas, measured at STP, occupies a volume of

- A) 2.24 L
- \*B) 22.4 L
- C) 2.24 mL
- D) 22.4 mL

12A.6.

30) A sample of  $O_2$  (oxygen), at STP, has a mass of 32 g. The mass of the same number of molecules of  $H_2$  (hydrogen) is

- A) 1.0 g
- \*B) 2.0 g
- C) 16 g
- D) 4.0 g

31) The relative molecular mass of fluorine gas is

- A) 9
- B) 18
- C) 19
- \*D) 38

32) 1.70 g of  $NH_3$  (ammonia gas) will, at STP, occupy approximately

- A) 0.224 L
- \*B) 2.24 L
- C) 17.0 L
- D) 22.4 L

33) The mass of 1 mol of ammonium carbonate ( $(NH_4)_2CO_3$ ) is approximately

- A) 43.0 g
- B) 72.0 g
- C) 78.0 g
- \*D) 96.0 g

12A.6.

- 34) Equal volumes of two different gases, A and B, are at the same temperature and pressure. The sample of gas A has a mass of 1.60 g and the sample of gas B has a mass of 3.55 g. Gas A is  $O_2$  (oxygen), therefore the relative molecular mass of gas B is

A)  $\frac{1.60}{3.55} \times 16$

B)  $\frac{3.55}{1.60} \times 16$

C)  $\frac{1.60 \times 1.6}{3.55}$

\*D)  $\frac{3.55}{1.60} \times 32$

- 35) 1.0 L of a gas, at standard conditions, has a mass of approximately 2.0 g. We may infer that the gas could be

A)  $H_2$  (hydrogen: relative molecular mass 2.0)

B)  $O_2$  (oxygen: relative molecular mass 32)

\*C)  $CO_2$  (carbon dioxide: relative molecular mass 44)

D)  $N_2$  (nitrogen: relative molecular mass 28)

- 36) An empty flask (one with all the air pumped out) is found to have a mass of 110.02 g. When filled with  $H_2(g)$  (hydrogen gas) the flask is found to have a mass of 110.06 g. When filled with an unknown gas, it has a mass of 110.66 g. Which one of the following formulae could be that of the unknown gas?

\*A)  $O_2$  (oxygen) - relative atomic mass = 16

B) He (helium) - relative atomic mass = 4

C)  $F_2$  (fluorine) - relative atomic mass = 19

D)  $H_2O$  (water) - relative atomic mass = 18

12A.6.

- 37) A 1.00 L sample of a gas, measured at STP, with simplest formula  $\text{CH}_3$  is found to have a mass of 1.34 g. The molecular formula for the gas is
- A)  $\text{C}_2\text{H}_2$
  - \*B)  $\text{C}_2\text{H}_6$
  - C)  $\text{C}_3\text{H}_9$
  - D)  $\text{C}_4\text{H}_{12}$
- 38) The molar mass of a compound with the empirical (simplest) formula  $\text{CH}_2\text{O}$  was found to be 122 g (approximately). What is the molecular formula of the compound?
- \*A)  $\text{C}_4\text{H}_8\text{O}_4$
  - B)  $\text{C}_2\text{H}_6\text{O}_2$
  - C)  $\text{C}_3\text{H}_3\text{O}_6$
  - D)  $\text{C}_3\text{H}_6\text{O}_3$
- 39) The number of moles of lead(II) nitrate in 1.66 g of  $\text{Pb}(\text{NO}_3)_2$  is
- A) 0.00101 mol
  - B) 0.00202 mol
  - C) 0.00300 mol
  - \*D) 0.00502 mol
- 40) The number of moles of Zn in 1.41 g of Zn is
- A) 0.0108 mol
  - \*B) 0.0216 mol
  - C) 0.0324 mol
  - D) 0.0432 mol

12A.6.

41) Three moles of  $\text{H}_2$  gas (hydrogen), measured at STP, occupy

- A) 11.2 L
- B) 22.4 L
- C) 44.8 L
- \*D) 67.2 L

42) The percentage chlorine, by mass, in  $\text{HClO}_3$  (chloric acid) is

- A) 24%
- B) 36%
- \*C) 42%
- D) 68%

43) The molar mass of aluminum sulfate,  $\text{Al}_2(\text{SO}_4)_3$ , is

- A) 123 g
- B) 278 g
- \*C) 342 g
- D) 450 g

44) Which of the following statements are correct?

- I) The gram-atomic mass of an element is equal to the mass of Avogadro's Number of atoms of the element.
- II) The molar mass is always equal to twice the atomic mass.
- III) The density of a gas has no relationship to its molar mass.
- IV) "22.4 L" of a gas at STP is called the "molar volume".

- A) I and II
- \*B) I and IV
- C) II and III
- D) II and IV

12A.6.

- 45) Equal masses of  $\text{H}_2$  (hydrogen) and  $\text{O}_2$  (oxygen) are placed in a container and the container is tightly stoppered. Which one of the following statements is true about the system?
- \*A) There are more hydrogen molecules than oxygen molecules in the container.
  - B) Both kinds of molecules have the same velocity in the container.
  - C) Both gases exert the same pressure on the walls of the container.
  - D) Both kinds of molecules strike the walls of the container with the same force.
- 46) The number of  $\text{O}_2$  (oxygen) molecules in 22.4 L of oxygen gas at STP, is
- A) 8.00
  - B) 16.0
  - C)  $6.02 \times 10^{20}$
  - \*D)  $6.02 \times 10^{23}$
- 47) The formula of sucrose is  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ . The number of atoms in one molecule of sucrose is
- A) 12
  - B) 34
  - C) 36
  - \*D) 45

12A.6.

48) What is the percentage, by mass, of magnesium in  $\text{MgSO}_4$  (magnesium sulfate)?

- A) 17%
- \*B) 20%
- C) 25%
- D) 33%

49) A quantity of silver nitrate ( $\text{AgNO}_3$ ) has a mass of 2.22 kg. How much of this mass is due to the silver in the compound?

- A) 0.240 kg
- \*B) 1.41 kg
- C) 1.73 kg
- D) 3.49 kg

50) The relative atomic masses of Ba, N and O are 137, 14.0 and 16.0 respectively; 26.1 g of  $\text{Ba}(\text{NO}_3)_2$  (barium nitrate) contains

- A) 1.4 g of nitrogen
- \*B) 2.8 g of nitrogen
- C) 5.6 g of nitrogen
- D) 8.4 g of nitrogen

51) The percentage by mass of oxygen in  $\text{MgO}$  (magnesium oxide) is

- A) 16%
- B) 24%
- \*C) 40%
- D) 60%

12A.6.

52) The ratio of hydrogen to oxygen, by mass, in  $\text{H}_2\text{O}$  (water) is

- \*A) 1:8
- B) 2:1
- C) 1:2
- D) 8:1

53) What is the percentage, by mass, of oxygen in  $\text{CO}_2$  (carbon dioxide)?

- A) 27.3%
- B) 36.4%
- C) 57.1%
- \*D) 72.7%

54) The composition, by mass, of a compound is 58.3% carbon, 10.7% hydrogen and 31.0% oxygen. The simplest formula of the compound is

- A)  $\text{CHO}$
- B)  $\text{C}_2\text{H}_5\text{O}$
- C)  $\text{C}_3\text{H}_6\text{O}_2$
- \*D)  $\text{C}_5\text{H}_{11}\text{O}_2$

55) A substance is found to contain 40% carbon, 6.67% hydrogen and 53.33% oxygen, by mass. What is the empirical (simplest) formula of the substance?

- A)  $\text{CHO}$
- B)  $\text{C}_2\text{HO}$
- \*C)  $\text{CH}_2\text{O}$
- D)  $\text{CH}_3\text{O}$

12A.6.

56) A 100 g sample of a compound is composed of 26.5 g of potassium, 35.4 g of chromium and the rest oxygen. The simplest formula of the compound is

- A)  $\text{KCrO}_4$
- \*B)  $\text{K}_2\text{Cr}_2\text{O}_7$
- C)  $\text{K}_2\text{Cr}_2\text{O}_8$
- D)  $\text{K}_{26}\text{Cr}_{35}\text{O}_{39}$

57) A compound is found to contain 80% carbon and 20% hydrogen by mass. The simplest formula of the compound is

- A)  $\text{CH}$
- B)  $\text{CH}_2$
- \*C)  $\text{CH}_3$
- D)  $\text{CH}_4$

58) There are two known chlorides of copper. A 9.90 g sample of the first contains 6.35 g of copper, while a 13.45 g sample of the second contains 6.35 g of copper. The simplest formulae for these two compounds are, respectively

- \*A)  $\text{CuCl}$ ,  $\text{CuCl}_2$
- B)  $\text{CuCl}_2$ ,  $\text{CuCl}$
- C)  $\text{CuCl}$ ,  $\text{Cu}_2\text{Cl}$
- D)  $\text{CuCl}_2$ ,  $\text{Cu}_2\text{Cl}$

59) A sample of a compound consists of 6.0 g of hydrogen and 36 g of carbon. The simplest formula of the compound is

- A)  $\text{C}_6\text{H}$
- B)  $\text{C}_{36}\text{H}_6$
- \*C)  $\text{CH}_2$
- D)  $\text{C}_2\text{H}$

12A.6.

- 60) A sample of a compound which contains only sulfur and oxygen is found to contain equal masses of the two elements. The simplest formula for the compound is
- A) SO
  - B) S<sub>2</sub>O
  - \*C) SO<sub>2</sub>
  - D) S<sub>2</sub>O<sub>3</sub>
- 61) The relative molecular mass for a hydrocarbon having a ratio of carbon to hydrogen atoms of 1 to 1 is 78. What is the molecular formula of the hydrocarbon?
- A) C<sub>2</sub>H<sub>2</sub>
  - B) CH<sub>6</sub>
  - C) C<sub>6</sub>H
  - \*D) C<sub>6</sub>H<sub>6</sub>
- 62) The simplest formula of a compound is one in which
- A) the atomic symbols are shown without subscripts
  - \*B) only the atomic ratios are given
  - C) the subscripts of the elements are 1
  - D) all of the subscripts are > 1
- 63) A compound contains 46.2% carbon and 53.8% nitrogen by mass. At STP 11.2 L of the gas has a mass of 26 g. The molecular formula of the compound is
- A) CN
  - B) CN<sub>2</sub>
  - \*C) C<sub>2</sub>N<sub>2</sub>
  - D) C<sub>4</sub>N<sub>4</sub>

12A.6.

64) A hydrocarbon gas has a relative molecular mass of approximately 44. The compound is 81.8% carbon and 18.2% hydrogen by mass. The molecular formula of the gas is

- A)  $C_2H_6$
- \*B)  $C_3H_8$
- C)  $C_4H_{10}$
- D)  $C_5H_{12}$

65) If the relative molecular mass of a compound with simplest formula  $CH_2O$  is 60, the molecular formula is

- A)  $CH_2O$
- \*B)  $C_2H_4O_2$
- C)  $C_4H_2O_4$
- D)  $C_4H_2O_6$

66) The compound octane has the simplest formula  $C_4H_9$ . Its relative molecular mass is 114. The molecular formula of octane is

- A)  $C_4H_9$
- \*B)  $C_8H_{18}$
- C)  $C_3H_5O$
- D)  $C_{12}H_{27}$

67) How many atoms are represented in the formula  $Na_2S_2O_3 \cdot 5H_2O$ ?

- A) 12
- B) 18
- \*C) 22
- D) 29

12A.6.

68) How many atoms are represented by the formula  $\text{Mg}(\text{OH})_2$

- \*A) 5
- B) 6
- C) 3
- D) 4

69) The total number of atoms in 2 mol of  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  is

- A)  $2 \times 22.4 \times 6.02 \times 10^{23}$
- B)  $2 \times 26 \times 6.02 \times 10^{23}$
- C)  $2 \times 27 \times 6.02 \times 10^{23}$
- \*D)  $2 \times 36 \times 6.02 \times 10^{23}$

70) The number of moles of molecules in 51 g of  $\text{NH}_3$  (ammonia, molar mass 17.0) is

- \*A) 3.00
- B) 3.40
- C) 6.80
- D) 867

71) The number of oxygen atoms represented in the formula  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  is

- A) 7
- \*B) 11
- C) 21
- D) 27

12A.6.

72) The relative molecular mass of the compound  $\text{Fe}_3(\text{Fe}(\text{CN})_6)_2$  is

- A) 138
- B) 539
- \*C) 591
- D) 870

73) What is the mass of 11.2 L of  $\text{C}_2\text{H}_2$  (acetylene) at STP?

- \*A) 13.0 g
- B) 26.0 g
- C) 52.0 g
- D) 4.00 g

74) 1.0 L of a gas, measured at STP, has a mass of 1.25 g. The relative molecular mass of this gas is approximately

- A) 1.25
- B)  $2 \times 1.25$
- C)  $12 \times 1.25$
- \*D)  $22.4 \times 1.25$

75) In an experiment, plastic bags of equal volume were filled with gases and massed. After correction for buoyancy, one bagful of oxygen gas ( $\text{O}_2$ ) was found to have a mass of 0.96 g. One bagful of gas X was found to have a mass of 0.84 g. What is the relative molecular mass of gas X?

- A) 14
- \*B) 28
- C) 48
- D) 56

12A.6.

76) A 1.00 L sample of gas (measured at STP) is found to have a mass of 1.34 g. What is the relative molecular mass of this gas?

- A) 22.4
- B) 24.4
- \*C) 30.0
- D) 59.8

77) A 7.00 g sample of an ideal gas occupies 5.60 L at STP. The relative molecular mass of this gas is

- A)  $5.60 \times 7.00$
- B)  $7.00 \times 22.4$
- C)  $\frac{5.60}{22.4} \times 7.00$
- \*D)  $\frac{22.4}{5.60} \times 7.00$

78) Equal volumes of  $O_2$  (oxygen) and a gas X have a mass of 0.96 g and 0.84 g respectively. What is the relative molecular mass of gas X?

- A) 24
- B) 26
- \*C) 28
- D) 32

79) 1.35 g of a gas at 298 K and 98.4 kPa occupies 1.60 L; the relative molecular mass of the gas is

- A) 11.6
- B) 18.9
- \*C) 21.1
- D) 44.5

12A.6.

80) The volume of one mole of an ideal gas, at 202 kPa and 273 K, is

- A) 5.60 L
- \*B) 11.2 L
- C) 22.4 L
- D) 44.8 L

81) In an experiment to produce  $H_2$  (hydrogen) from magnesium and an acid, the following data were obtained

Mass of magnesium used	0.079 g
Volume of hydrogen collected	73.2 mL
Atmospheric pressure	108 kPa
Water vapour pressure	2.7 kPa
Room temperature	298 K

(The relative atomic mass of Mg is 24.3)

The molar volume of  $H_2$  at 101 kPa and 298 K as calculated from the data given above is

- A) 22.4 L
- \*B) 23.4 L
- C) 25.2 L
- D) 36.6 L

82) What is the mass of 1 L of  $Cl_2(g)$  (chlorine gas), measured at STP?

- \*A) 3.17 g
- B) 22.4 g
- C) 35.5 g
- D) 71.0 g

12A.6.

- 83) What volume of  $\text{CO}_2$  (carbon dioxide gas) at STP is produced when 1 mol of  $\text{O}_2$  (oxygen) is consumed, according to the following equation?



- A)  $\frac{1}{2} \times 22.4 \text{ L}$
- \*B)  $\frac{2}{3} \times 22.4 \text{ L}$
- C)  $\frac{3}{2} \times 22.4 \text{ L}$
- D)  $2 \times 22.4 \text{ L}$
- 84) At STP, the volume occupied by 1.28 g of  $\text{SO}_2$  (sulfur dioxide) is

- \*A) 0.448 L
- B) 0.896 L
- C) 1.28 L
- D) 2.24 L

- 85) The mass of 5.6 L of helium (He) at STP is

- \*A) 1.0 g
- B) 2.0 g
- C) 16 g
- D) 4.0 g

- 86) 1.00 mol of  $\text{H}_2$  (hydrogen), 1.00 mol of  $\text{N}_2$  (nitrogen), 1.00 mol of  $\text{O}_2$  (oxygen) and 3.00 mol of  $\text{CO}_2$  (carbon dioxide), are injected into a rigid 22.4 L container at 273 K. The total pressure in the system is

- A) 101 kPa
- \*B) 608 kPa
- C)  $1.22 \times 10^3 \text{ kPa}$
- D)  $8.47 \times 10^3 \text{ kPa}$

12A.6.

87) There are  $12.04 \times 10^{23}$  molecules of hydrogen,  $H_2$ , in a container having a capacity of 11.2 litres. The pressure in the container at 273 K is

- A) 101 kPa
- B) 202 kPa
- C) 303 kPa
- \*D) 404 kPa

88) Which of the following statements about the relation  $PV = nRT$  are true?

- I) It applies to real gases
- II) It applies to ideal gases
- III) The volume of a given mass of gas varies inversely as its absolute temperature
- IV) If the number of molecules of a gas is increased when temperature and volume remain the same, the pressure exerted by the gas is increased

- A) I and III
- \*B) II and IV
- C) I and IV
- D) II and III

89) The number of moles of calcium in 10 g of calcium carbonate ( $CaCO_3$ ) is

- \*A) 0.10
- B) 0.40
- C) 4.0
- D) 10

12A.6.

90) The number of atoms represented by the formula  $\text{Al}_2(\text{SO}_4)_3$  is

- A) 10
- \*B) 17
- C) 34
- D) 42

91) An analysis of a compound gives the following results (by mass):

Carbon	Hydrogen	Oxygen
40%	6.7%	53.3%

The simplest formula of the compound is

- A)  $\text{C}_2\text{HO}$
- B)  $\text{CHO}_2$
- \*C)  $\text{CH}_2\text{O}$
- D)  $\text{C}_2\text{HO}_2$

92) The formula for calcium carbonate is  $\text{CaCO}_3$ . Its percentage composition, by mass, is

	Calcium	Carbon	Oxygen
A)	38	40	22
*B)	40	12	48
C)	45	15	40
D)	50	10	40

93) How many moles of sulfur atoms are present in 48 g of sulfur?

- A) 0.67
- \*B) 1.5
- C) 16
- D)  $9.03 \times 10^{23}$

12A.6.

94) The relative molecular mass of  $\text{N}_2\text{H}_4$  is

- A) 9.0
- B) 11
- C) 18
- \*D) 32

95) Equal volumes of two different gases, A and B, are at the same temperature and pressure. The sample of gas A has a mass of 1.60 g and the sample of gas B has a mass of 3.55 g. The ratio of the mass of one molecule of A to one molecule of B is

- \*A)  $\frac{1.60}{3.55}$
- B)  $\frac{3.55}{1.60}$
- C)  $1.60 \times 3.55$
- D)  $\frac{1.60}{3.55} \times 6.03 \times 10^{23}$

96) How many moles of nitrogen atoms are there in 1 mol of  $(\text{NH}_4)_3\text{PO}_4$  (ammonium phosphate)?

- A) 12
- B) 2
- \*C) 3
- D) 13

97) What is the mass of nitrogen in 0.500 mol of  $\text{NH}_3$  (ammonia)?

- A) 14.0 g
- \*B) 7.00 g
- C) 17.0 g
- D)  $0.500 \times 6.02 \times 10^{23}$  g

12A.6.

- 98) The density of a gas at STP is 2.0 g/L. The relative molecular mass of this gas is most nearly
- A) 23
  - B) 36
  - \*C) 45
  - D) 64
- 99) From analysis, the simplest formula of a compound is determined to be  $\text{CH}_2\text{N}_2$ . The molar mass of the compound is determined experimentally to be 126 g. The true formula of the compound is
- \*A)  $\text{C}_3\text{H}_6\text{N}_6$
  - B)  $\text{C}_3\text{H}_8\text{N}_6$
  - C)  $\text{CH}_2\text{N}_2$
  - D)  $\text{C}_2\text{H}_4\text{N}_4$
- 100) Given that the relative atomic masses of Pb, H, Fe, Ca and He are 207, 1.0, 56, 40 and 4.0 respectively, 20.7 g of lead has approximately the same number of atoms as
- A) 1.0 g of hydrogen
  - \*B) 5.6 g of iron
  - C) 56 g of calcium
  - D) 4.0 g of helium

12A.6.

101) The composition of a compound may be determined by

- A) distilling it
- \*B) decomposing it
- C) finding its melting point
- D) finding its density

102) A mole is

- A) 22.4 L
- \*B)  $6.02 \times 10^{23}$  particles
- C) one molecule
- D) one molar mass

103) How many moles of  $\text{CO}_2$  molecules are there in 176 g of carbon dioxide ( $\text{CO}_2$ )?

- A)  $24.08 \times 10^{23}$
- B)  $6.02 \times 10^{23}$
- C) 44
- \*D) 4

104) The number of hydrogen atoms in 0.500 mol of hydrogen gas is

- A)  $32.0 \times 10^{23}$
- B)  $16.0 \times 10^{23}$
- \*C)  $6.02 \times 10^{23}$
- D)  $30.1 \times 10^{23}$

12A.6.

105) The relative atomic mass of copper is 63.5. The mass of Avogadro's number of copper atoms is

- A) 1 g
- B)  $63.5 \times 6.02 \times 10^{23}$  g
- \*C) 63.5 g
- D)  $6.02 \times 10^{23}$  g

106) The number of particles in a mole is

- A)  $23 \times 10^6$
- B)  $2.06 \times 10^{23}$
- C)  $10 \times 6.02^{23}$
- \*D)  $6.02 \times 10^{23}$

107) Consult the periodic table to obtain the relative atomic masses necessary to answer this question. A mass of 20.7 g of lead consists of approximately the same number of atoms as

- \*A) 5.6 g of iron
- B) 23 g of sodium
- C) 1.0 g of hydrogen
- D) 56 g of calcium

108) The relative atomic mass of magnesium is 24.3. The mass of 0.250 mol of magnesium is

- \*A) 6.08 g
- B) 112 g
- C)  $1.51 \times 10^{23}$  g
- D)  $3.66 \times 10^{24}$  g





12A.6.

109) How many moles of sulphur atoms are present in 48 g of sulphur?

- A) 0.67 mol
- \*B) 1.5 mol
- C)  $4.0 \times 10^{23}$  mol
- D)  $9.0 \times 10^{23}$  mol

110) The relative molecular mass of hydrogen is (approximately)

- A) 1
- \*B) 2
- C) 22.4
- D) 101.3

111) The relative formula mass of aluminum sulphate,  $\text{Al}_2(\text{SO}_4)_3$  is

- A) 123
- B) 278
- \*C) 342
- D) 450

112) The relative formula mass of  $(\text{NH}_4)_2\text{CO}_3$  is

- A) 46
- B) 78
- \*C) 96
- D) 120

113) The number of moles of ammonia in 51 g of  $\text{NH}_3$  is

- A) 0.33
- B) 1.2
- \*C) 3.0
- D) 17

12A.6.

114) The number of moles of ammonia in 510 g of ammonia ( $\text{NH}_3$ ) is

- A) 0.033 mol
- B) 5.1 mol
- C) 17 mol
- \*D) 30 mol

115) Avogadro's Principle states that at the same temperature and pressure

- A) all molecules in the gaseous state are the same size
- \*B) the volumes occupied by the same number of molecules are the same
- C) volumes occupied by equal numbers of molecules are proportional to their masses
- D) equal masses of all gases contain the same number of molecules

116) The molar volume of hydrogen gas, at S.T.P., is

- A) 1.00 L
- B) 6.02 L
- \*C) 22.4 L
- D) 273 L

117) Which of the following has the largest molar volume, at  $25^\circ\text{C}$ , and a pressure of 100 kPa?

- A) water
- \*B) neon
- C) potassium
- D) sulphur

12A.6.

118) One litre of an ideal gas at S.T.P. has a mass of 1.25 g.  
The molar mass of the gas is

- A) 0.625 g
- B) 1.25 g
- C) 22.4 g
- \*D) 28.0 g

119) The molar mass of  $\text{Al}_2(\text{CO}_3)_3$  is

- A) 114 g
- B) 207 g
- C) 210 g
- \*D) 234 g

120) The molar mass of ammonium sulphate,  $(\text{NH}_4)_2\text{SO}_4$  is

- A) 84 g
- B) 114 g
- \*C) 132 g
- D) 228 g

121) The mass of one litre of an ideal gas at S.T.P. is 5.80 g.  
The molar mass of the gas is approximately

- A) 0.250 g
- B) 5.80 g
- C) 58.0 g
- \*D) 130 g

12A.6.

122) The mass of 1.00 L of an ideal gas at S.T.P. is 4.82 g.  
The molar mass of the gas is approximately

- A) 4.68 g
- B) 4.82 g
- C) 54.0 g
- \*D) 108 g

123) The mass in grams of 11.2 L of gaseous ammonia ( $\text{NH}_3$ ) at 101 kPa and  $0.00^\circ\text{C}$  is (assuming ideal behaviour)

- A) 0.50
- \*B) 8.50
- C) 17.0
- D) 22.4

124) The density of an ideal gas at S.T.P. is 3.0 g/L. The molar mass of this gas is most nearly

- A) 11.2 g
- B) 22.4 g
- C) 3.00 g
- \*D) 67.2 g

125) 500 mL of an ideal gas at standard conditions (STP) has a mass of 0.984 g. The molar mass of the gas is

- A) 1.97 g
- B) 22.0 g
- \*C) 44.1 g
- D) 98.4 g

12A.6.

126) The mass of one litre of an ideal gas is 2.00 g at 202 kPa and 273°C. The molar mass of the gas is

- A) 11.2 g
- B) 22.4 g
- C) 33.6 g
- \*D) 44.8 g

127) An ideal gas has a density of 1.20 g/L at STP. The molar mass of the gas is

- A) 18.7 g
- B) 25.4 g
- \*C) 26.9 g
- D) 44.2 g

128) The percentage by mass of carbon in glucose ( $C_6H_{12}O_6$ ) is

- A) 6.7%
- B) 25%
- \*C) 40%
- D) 67%

129) The percentage of phosphorus (P), by mass, in  $H_3PO_4$  is

- A) 13%
- \*B) 32%
- C) 46%
- D) 62%

130) The percentage, by mass, of nitrogen in  $(NH_4)_3PO_4$  is

- A) 9.40%
- B) 12.4%
- \*C) 28.2%
- D) 36.2%

12A.6.

131) What is the percentage, by mass, of titanium in titanium(IV) chloride ( $\text{TiCl}_4$ )?

- A) 18.7%
- B) 20.0%
- \*C) 25.2%
- D) 57.5%

132) The percentage of hydrogen, by mass, in acetic acid ( $\text{CH}_3\text{COOH}$ ) is

- A) 5.0%
- B) 1.7%
- \*C) 6.7%
- D) 50%

133) The percentage by mass of oxygen in calcium carbonate,  $\text{CaCO}_3$ , is

- A) 16%
- B) 24%
- C) 39%
- \*D) 48%

134) How many grams of water ( $\text{H}_2\text{O}$ ) are contained in 244 g of  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ ?

- A) 18.0
- B) 2.00
- \*C) 36.0
- D) 122

12A.6.

135) The percentage of water by mass in  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  is

- A) 45%
- B) 50%
- \*C) 63%
- D) 73%

136) The simplest formula of a compound that contains 90% carbon and 10% hydrogen by mass is

- \*A)  $\text{C}_3\text{H}_4$
- B)  $\text{CH}_4$
- C)  $\text{C}_2\text{H}_3$
- D)  $\text{C}_4\text{H}_5$

137) A compound was found to contain 80%, by mass, carbon and 20%, by mass, hydrogen. The simplest formula of this compound is

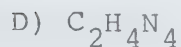
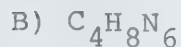
- A)  $\text{CH}_2$
- \*B)  $\text{CH}_3$
- C)  $\text{C}_2\text{H}$
- D)  $\text{C}_3\text{H}_2$

138) A hydrocarbon contains 92.3% carbon and 7.7% hydrogen (by mass). The simplest formula of the compound is

- A)  $\text{C}_2\text{H}$
- B)  $\text{CH}_2$
- \*C)  $\text{CH}$
- D)  $\text{CH}_{12}$

12A.6.

139) By analysis, the simplest formula of a compound is determined to be  $\text{CH}_2\text{N}_2$ . The molar mass is determined experimentally to be approximately 128 g. The true formula is



140) A compound of empirical formula  $\text{CH}_2\text{O}$  might have a relative molecular mass of

A) 15

B) 45

C) 75

\*D) 90

141) The simplest formula of a gas is  $\text{CH}$ ; 11.2 L of this gas at STP has a mass of 13 g. The molecular formula of the gas is (assuming ideal behaviour)

A)  $\text{CH}$

B)  $2\text{CH}$

\*C)  $\text{C}_2\text{H}_2$

D)  $\text{CH}_{14}$

142) In 11.0 g of carbon dioxide, there are

A) 0.500 mol of carbon atoms

\*B) 0.500 mol of oxygen atoms

C) 0.250 mol of oxygen atoms

D) 0.830 mol of carbon atoms

12A.6.

143) The number of phosphorus atoms in 3.00 mol of phosphorus ( $P_4$ ) molecules is

- A)  $6.02 \times 10^{23}$  atoms
- B)  $1.81 \times 10^{24}$  atoms
- C)  $2.41 \times 10^{24}$  atoms
- \*D)  $7.22 \times 10^{24}$  atoms

144) 1.70 g of ammonia gas ( $NH_3$ ) will, at S.T.P., occupy approximately

- \*A) 2.24 L
- B) 17.0 L
- C) 22.4 L
- D) 0.224 L

145) The mass of 11.2 L of gaseous acetylene ( $C_2H_2$ ), measured at S.T.P., is approximately

- \*A) 13 g
- B) 24 g
- C) 26 g
- D) 48 g

146) The number of atoms of oxygen in 205.5 g of  $Al(BrO_3)_3$  is

- A)  $3.010 \times 10^{23}$
- B)  $9.030 \times 10^{23}$
- C)  $1.806 \times 10^{24}$
- \*D)  $2.709 \times 10^{24}$

12A.6.

147) A compound is 92.3% carbon and 7.7% hydrogen, by mass. The simplest formula of this compound is

- \*A) CH
- B) CH<sub>4</sub>
- C) C<sub>2</sub>H<sub>6</sub>
- D) C<sub>6</sub>H<sub>6</sub>

148) Which one of the following statements is correct?

- A) Relative molecular mass is always equal to twice the relative atomic mass.
- B) The density of a gas has no relationship to its relative molecular mass.
- C) The volume of one mole of a solid is 22.4 L.
- \*D) The molar mass is the mass of Avogadro's number of molecules.

149) How many moles of ammonia (NH<sub>3</sub>) are equivalent to  $18.0 \times 10^{23}$  molecules of ammonia?

- A) 0.750
- B) 1.50
- \*C) 3.00
- D) 6.02

150) The relative molecular mass of a compound is 32 and the simplest formula is CH<sub>4</sub>O. The true molecular formula of the compound is

- \*A) CH<sub>4</sub>O
- B) C<sub>2</sub>H<sub>8</sub>O<sub>2</sub>
- C) C<sub>3</sub>H<sub>12</sub>O<sub>3</sub>
- D) C<sub>5</sub>H<sub>10</sub>O<sub>5</sub>

12A.6.

151) How many atoms are represented in the formula  $\text{Fe}_3(\text{Fe}(\text{CN})_6)_2$ ?

- A) 16
- B) 17
- \*C) 29
- D) 39

152) The percentage of hydrogen, by mass, in propanol ( $\text{C}_3\text{H}_7\text{OH}$ ) is

- A) 5.9%
- B) 11.7%
- \*C) 13.3%
- D) 26.6%

153) If 1.00 L of a gas at STP has a mass of 3.60 g, its molar mass is

- A) 13.0 g
- B) 18.0 g
- C) 36.0 g
- \*D) 80.6 g

154) The formula for oxygen gas is known to be  $\text{O}_2$ . Given that the relative atomic mass of O is 16.0, the formula  $\text{O}_2$  is consistent with a density, at STP, of

- A) 1.00 g/L
- B) 0.72 g/L
- \*C) 1.43 g/L
- D) 22.4 g/L

12A.6.

155) The relative atomic mass of magnesium (Mg) is 24.3.  
The mass of 0.250 mol of magnesium is

- \*A) 6.08 g
- B) 24.1 g
- C) 97.2 g
- D)  $1.51 \times 10^{23}$  g

156) One litre of a gas at STP has a mass of 1.25 g. The relative molecular mass of the gas is

- A) 0.0560
- B) 1.25
- C) 17.9
- \*D) 28.0

157) According to the following equation the volume of oxygen ( $O_2$ ), at STP, needed to completely burn 22.4 L of methane ( $CH_4$ ) gas, at STP, is



- A) 2.00 L
- B) 11.2 L
- C) 22.4 L
- \*D) 44.8 L

12A.6.

- 158) What mass of water,  $\text{H}_2\text{O}$ , would be needed to produce 112 L of hydrogen,  $\text{H}_2$ , at STP, according to the following equation?



- A) 36.0 g
- B) 45.0 g
- \*C) 90.0 g
- D) 112 g

- 159) The composition, by mass, of a compound is C = 37.5%, H = 12.5%, O = 50.0%. The ratio of the atoms (C:H:O) in the compound corresponds to:

- A) 1:1:1
- B) 1:3:2
- C) 37.5: 12.5:50.0
- \*D) 1:4:1

- 160) In a mass spectrograph, the ions which are likely to undergo the greatest deflection have

- A) greatest charge and largest mass
- \*B) greatest charge and smallest mass
- C) smallest charge and largest mass
- D) smallest charge and smallest mass

- 161) If 22.4 L of a gas at STP has a mass of 44 g, its relative molecular mass is

- A)  $\frac{44}{22.4}$
- \*B) 44
- C) 88
- D)  $44 \times 22.4$

12A.6.

162) The relative molecular mass of  $(\text{NH}_4)_2\text{SO}_4$  is

- A) 66.0
- B) 100
- C) 118
- \*D) 132

163) The composition, by mass, of a compound is C = 60.0%, H = 13.3%, O = 26.7%. The simplest formula of this compound is

- A) CHO
- B)  $\text{C}_3\text{HO}$
- \*C)  $\text{C}_3\text{H}_8\text{O}$
- D)  $\text{CH}_8\text{O}$

164) The relative molecular mass of  $\text{C}_6\text{H}_5\text{OCOCH}_3 \cdot \text{COOH}$  is

- A) 136
- B) 169
- \*C) 181
- D) 295

165) 2.25 L of a gas, at STP, has a mass of 6.15 g; the relative molecular mass of the gas is

- A) 6.15
- B) 13.8
- \*C) 61.2
- D) 138

12A.6.

166) The mass of one molecule of  $C_2H_2$  (acetylene) is:

- \*A)  $4.32 \times 10^{-23}g$
- B)  $2.3 \times 10^{22} g$
- C) 4.32 g
- D) 26.0 g

167) A particular oxide of sulphur contains 50% oxygen, by mass. A sample of this compound, when decomposed, produced one volume of sulphur vapour,  $S_8$ . How many volumes of oxygen gas were produced at the same temperature and pressure?

- \*A) 8
- B) 2
- C) 16
- D) 4

168) A particular oxide of sulphur contains 50% oxygen, by mass. A sample of this compound, when decomposed, produced one volume of sulphur vapour,  $S_8$ . The simplest formula of the compound is

- A) SO
- \*B)  $SO_2$
- C)  $S_2O$
- D)  $SO_3$

169) The formula of acetic acid is  $CH_3COOH$ . The mass of 0.050 mol of acetic acid is

- A) 12 g
- B) 30 g
- \*C) 3.0 g
- D) 60 g

12A.6.

- 170) The pressure in a 500 mL flask is 33.0 kPa at 284 K. The gas constant,  $R = \frac{8.31 \text{ L}\cdot\text{kPa}}{\text{K}\cdot\text{mol}}$ . The number of moles of gas present in the flask is
- \*A) 0.00700
  - B) 7.00
  - C) 143
  - D) 181
- 171) The number of grams of hydrogen sulfate ( $\text{H}_2\text{SO}_4$ ) in 0.25 mol of hydrogen sulfate is
- A) 0.245
  - \*B) 24.5
  - C) 98.0
  - D) 400
- 172) What is the relative molecular mass of  $\text{C}_2\text{H}_6\text{O}$ ?
- A) 29
  - B) 34
  - \*C) 46
  - D) 68
- 173) 2.00 L of a gas at 273 K and 101.3 kPa pressure has a mass of 5.60 g. The relative molecular mass of the gas is
- A) 6.27
  - B) 24.5
  - \*C) 62.7
  - D) 251

12A.6.

174) The number of moles of sodium chloride ( $\text{NaCl}$ ) in 8.82 g of sodium chloride is

- \*A) 0.151
- B) 0.248
- C) 0.303
- D) 0.383

175) The molecular formula of a compound whose simplest formula is  $\text{CH}_2\text{O}$  and whose relative molecular mass is 60.0 is

- A)  $\text{CH}_2\text{O}$
- B)  $\text{C}_2\text{H}_4\text{O}$
- \*C)  $\text{C}_2\text{H}_4\text{O}_2$
- D)  $\text{C}_3\text{H}_6\text{O}_3$

176) One mole of a pure substance contains approximately

- A)  $2.17 \times 10^{-18}$  molecules
- B)  $2.24 \times 10^5$  molecules
- C)  $2.3 \times 10^{23}$  molecules
- \*D)  $6.02 \times 10^{23}$  molecules

177) A sample of oxygen ( $\text{O}_2$ ) at STP has a mass of 8.0 g.  
The mass of an equal volume of hydrogen ( $\text{H}_2$ ) at STP is

- \*A) 0.50 g
- B) 48 g
- C) 64 g
- D) 4.0 g

12A.6.

178) How many moles of nitrogen,  $N_2$ , are there in 33.6 L of nitrogen at standard temperature and pressure?

- A) 1.0
- \*B) 1.5
- C) 3.0
- D) 4.5

179) How many moles of sulfur dioxide ( $SO_2$ ) are there in 64 g of sulphur dioxide?

- \*A) 1.0
- B) 2.0
- C) 3.0
- D) 4.0

180) The composition of a compound, by mass, is 40.0% carbon, 6.7% hydrogen and 53.3% oxygen. The simplest formula of the compound is

- A)  $C_{75}H_{127}O_{127}$
- \*B)  $CH_2O$
- C)  $CHO$
- D)  $C_2H_2O_2$

181) Magnesium chloride is 25.6% magnesium (Mg) and 74.4% chlorine (Cl), by mass. Which of the following statements is correct?

- A) 24.3 g Mg combine with 35.5 g of Cl to form 59.8 g of magnesium chloride.
- \*B) 25.6 g of Mg combine with 74.4 g of Cl to form 100 g magnesium chloride.
- C) 25.6 mol of Mg combine with 74.4 mol of chlorine.
- D) One mole of magnesium atoms combines with one mole of chlorine atoms.

12A.6.

182) The number of atoms of oxygen in 0.500 mol of oxygen  $O_2$  is

- A)  $3.01 \times 10^{23}$
- B)  $16.0 \times 10^{23}$
- \*C)  $6.02 \times 10^{23}$
- D) 11.2

183) 1.00 L of a particular gas, at STP, has a mass of 4.80 g. Its molecular mass is

- A) 0.210 g
- B) 4.80 g
- \*C) 108 g
- D) 22.4 g

184) A volume of  $H_2$  (hydrogen gas) in a closed container is heated from 273 K to 546 K, the mass of gas will

- A) become 1/273 as great
- B) become half as great
- \*C) remain the same
- D) become twice as great

185) The simplest formula of a compound, relative molecular mass 46.0, is  $NO_2$ . The molecular formula of this compound is

- \*A)  $NO_2$
- B)  $NO_4$
- C)  $N_2O_4$
- D)  $N_4H_8$

12A.6.

186) One atom of magnesium, relative atomic mass = 24, has a mass of

- A)  $2.0 \times 10^{-23}$  g
- B)  $2.0 \times 10^{23}$  g
- \*C)  $4.0 \times 10^{-23}$  g
- D)  $4.0 \times 10^{23}$  g

187) The number of molecules of  $O_2$  (oxygen) in 1.0 L of  $O_2$  at STP is

- A)  $6.02 \times 10^{23}$
- B)  $\frac{6.02 \times 10^{23}}{16}$
- C)  $\frac{6.02 \times 10^{23}}{32}$
- \*D)  $\frac{6.02 \times 10^{23}}{22.4}$

188) 1.00 g of  $H_2$  (hydrogen) at STP occupies

- A) 1.00 L
- B) 2.00 L
- \*C) 11.2 L
- D) 22.4 L

189) The simplest formula of a compound is  $CH_3O$ . Its relative molecular mass is 62. The correct molecular formula of the compound is

- A)  $CHO$
- B)  $CH_3O$
- \*C)  $C_2H_6O_2$
- D)  $C_3H_9O_3$

12A.6.

190) Which of the following pairs of terms express the same idea?

- A) atom and compound
- B) gram and element
- \*C) mole and Avogadro's number of atoms
- D) mole and chemical reaction

191) The ratio of hydrogen to oxygen, by mass, in water is

- A) 2:1
- B) 1:2
- C) 8:1
- \*D) 1:8

192) The relative atomic mass of calcium is 40.08. The mass of 0.5000 mol of calcium is

- A) 0.500 g
- \*B) 20.04 g
- C) 40.08 g
- D) 40.58 g

193) The total number of atoms represented by the formula  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  is

- A) 15
- B) 27
- \*C) 36
- D) 38

12A.6.

194) The relative molecular mass of  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$  (barium chloride dihydrate) is approximately

- A) 208
- B) 212
- C) 228
- \*D) 244

195) How many molecules of carbon dioxide are contained in 66 g of  $\text{CO}_2$  (carbon dioxide, molar mass 44 g)?

- \*A)  $1.5 \times 6.02 \times 10^{23}$
- B)  $3 \times 6.02 \times 10^{23}$
- C)  $66 \times 6.02 \times 10^{23}$
- D)  $0.75 \times 6.02 \times 10^{23}$

196) The formula for calcium carbonate is  $\text{CaCO}_3$ . The percent composition of calcium carbonate, by mass, is

- |     | Ca | C  | O  |
|-----|----|----|----|
| A)  | 38 | 40 | 22 |
| *B) | 40 | 12 | 48 |
| C)  | 45 | 15 | 40 |
| D)  | 50 | 10 | 40 |

197) The relative atomic mass of an element always has the same numerical value as the

- A) mass number
- B) mass of one atom
- C) mass of one molecule
- \*D) mass of Avogadro's Number of atoms

12A.6.

198) The relative atomic mass of helium (He) is 4.0. The mass of 5.6 L of He at STP is

- \*A) 1.0 g
- B) 8.0 g
- C) 11.2 g
- D) 4.0 g

199) Oxygen gas molecules contain two atoms per molecule. The number of atoms in one mole of oxygen gas is

- A)  $6.02 \times 10^{23}$
- \*B)  $2 \times 6.02 \times 10^{23}$
- C)  $32 \times 6.02 \times 10^{23}$
- D)  $\frac{6.02 \times 10^{23}}{2}$

200) The number of molecules of oxygen ( $O_2(g)$ ) in 1.00 L of the gas at STP is

- A)  $\frac{6.02 \times 10^{23}}{32.0}$
- \*B)  $\frac{6.02 \times 10^{23}}{22.4}$
- C)  $\frac{6.02 \times 10^{23}}{16}$
- D)  $6.02 \times 10^{23}$

201) A compound consists of 92.3% carbon and 7.7% hydrogen, by mass. The empirical (simplest) formula of the compound is

- A)  $CH_3$
- B)  $CH_2$
- \*C) CH
- D)  $C_2H$

12A.6.

202) A 7.00 g sample of a gas occupies 5.60 L at STP. The molar mass of this gas is

- A)  $5.60 \times 7.00 \text{ g}$
- B)  $7.00 \times 22.4 \text{ g}$
- C)  $\frac{5.60 \times 7.00}{22.4} \text{ g}$
- \*D)  $\frac{22.4 \times 7.00}{5.60} \text{ g}$

203) The number of molecules of benzene ( $\text{C}_6\text{H}_6$ , relative molecular mass 78.0) present in 13.0 g of benzene is

- A)  $\frac{13.0}{6.02 \times 10^{23}}$
- B)  $\frac{78.0}{6.02 \times 10^{23}}$
- \*C)  $\frac{13.0}{78.0} \times 6.02 \times 10^{23}$
- D)  $13.0 \times 6.02 \times 10^{23}$

204) A plastic bag was massed when filled with  $\text{O}_2$  (oxygen gas) and again when filled with gas X. Gas X is known to consist of molecules which contain only carbon and hydrogen atoms in a 1 to 1 ratio. The oxygen in the bag has a mass of 0.32 g. The same volume of gas X, under identical conditions of temperature and pressure, has a mass of 0.26 g.

The molecular formula of gas X is

- A) CH
- \*B)  $\text{C}_2\text{H}_2$
- C)  $\text{C}_3\text{H}_3$
- D)  $\text{C}_4\text{H}_4$

12A.6.

205) The molar mass of sodium carbonate decahydrate  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  is

- A) 69.0
- B) 124
- C) 231
- \*D) 286

206) How many atoms are represented in the formula  $(\text{NH}_4)_3\text{PO}_4$ ?

- A) 1
- B) 18
- \*C) 20
- D) 4

12A.7.

1) When magnesium is burned in oxygen, the substance formed has the formula

- A)  $\text{MnO}_2$
- B)  $\text{MgO}_2$
- C)  $\text{Mg}_2\text{O}$
- \*D)  $\text{MgO}$

2) How many oxygen atoms are there in the formula  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$  (sodium sulfate decahydrate)?

- A) 5
- \*B) 14
- C) 40
- D) 4

3) Two molecules of water are best represented by the expression

- A)  $\text{H}_2\text{O}$
- B)  $\text{H}_4\text{O}_2$
- \*C)  $2\text{H}_2\text{O}$
- D)  $2\text{HO}_2\text{H}$

4) The set which contains three correct formulae is

- A)  $\text{Al}_2(\text{SO}_4)_3$ ,  $\text{MgI}$ ,  $\text{KCl}$
- B)  $\text{Ca}_3(\text{PO}_4)_2$ ,  $\text{Al}_2(\text{SO}_4)_3$ ,  $\text{Ag}(\text{OH})_3$
- \*C)  $\text{MgBr}_2$ ,  $\text{Na}_2\text{SO}_4$ ,  $\text{Zn}(\text{OH})_2$
- D)  $\text{Ag}(\text{OH})_2$ ,  $\text{NaOH}$ ,  $\text{ZnO}_3$

12A.7.

5) The symbol for antimony is

- A) Hg
- B) An
- C) Si
- \*D) Sb

6) An example of a binary compound is

- A) NaOH sodium hydroxide
- B) O<sub>2</sub> oxygen
- \*C) H<sub>2</sub>S hydrogen sulphide
- D) Co cobalt

7) The formula of telluric acid is H<sub>2</sub>TeO<sub>4</sub>; the formula of tellurous acid is likely to be

- A) H<sub>2</sub>TeO
- B) H<sub>2</sub>TeO<sub>2</sub>
- \*C) H<sub>2</sub>TeO<sub>3</sub>
- D) H<sub>2</sub>TeO<sub>5</sub>

8) Which one of the following acids is followed by the correct name of the salts it forms?

- \*A) chlorous acid - chlorite
- B) sulfurous acid - sulfate
- C) nitrous acid - nitrate
- D) carbonic acid - carbide

12A.7.

- 9) The name corresponding to the formula  $\text{Na}_2\text{SO}_3$  is
- A) sodium sulfide
  - \*B) sodium sulfite
  - C) sodium sulfate
  - D) sodium sulfur trioxide
- 10) In which of the following pairs of formulae are both chemical formulae correct?
- A)  $\text{KBr}$ ,  $\text{CaOH}$
  - \*B)  $\text{H}_2\text{SO}_3$ ,  $\text{CCl}_4$
  - C)  $\text{MgO}$ ,  $\text{ZnBr}$
  - D)  $\text{NaO}$ ,  $\text{MgCO}_3$
- 11) The electrovalence of copper, in most copper compounds, is
- \*A) 1+ or 2+
  - B) 1+ or 3+
  - C) 2+ or 3+
  - D) 3+ or 5+
- 12) Magnesium bromide is composed of the ions
- \*A)  $\text{Mg}^{2+}$      $\text{Br}^-$      $\text{Br}^-$
  - B)  $\text{Mg}^+$      $\text{Mg}^+$      $\text{Br}^-$
  - C)  $\text{Mg}^{2+}$      $\text{Br}^{2-}$
  - D)  $\text{Mg}^+$      $\text{Br}^-$

12A.7.

13) A compound with the chemical formula  $\text{HgCl}_2$  would best be named

- A) mercury(I) chloride
- B) mercurous chloride
- \*C) mercury(II) chloride
- D) mercury chloride

14) If X represents an element in Group 3, its oxide will have the formula

- A)  $\text{X}_3\text{O}_2$
- B)  $\text{XO}$
- \*C)  $\text{X}_2\text{O}_3$
- D)  $\text{X}_4\text{O}_3$

15)  $\text{XF}_2$  is the simplest formula of a metallic fluoride. The simplest formula of the corresponding metallic oxide of X is

- A)  $\text{XO}_2$
- B)  $\text{XO}_4$
- C)  $\text{X}_2\text{O}$
- \*D)  $\text{XO}$

16) Which one of the following formulae violates common valency rules?

- A)  $\text{Cu}_2\text{O}$
- B)  $\text{NaOH}$
- C)  $\text{Ba}(\text{HCO}_3)_2$
- \*D)  $\text{ZnCl}_3$

12A.7.

17) The correct name for the compound  $\text{KMnO}_4$  is

- A) calcium manganate
- \*B) potassium permanganate
- C) potassium hypomanganate
- D) potassium manganese oxide

18) The formula for ammonium phosphate is

- A)  $\text{NH}_3\text{PO}_3$
- \*B)  $(\text{NH}_4)_3\text{PO}_4$
- C)  $(\text{NH}_4)_4(\text{PO}_3)_2$
- D)  $(\text{NH}_4)_2\text{PO}_3$

19) The acid from which  $\text{NaBrO}_2$  is derived is called

- A) bromic acid
- \*B) bromous acid
- C) hydrobromic acid
- D) hypobromous acid

20) Two molecules of carbon dioxide are best represented by the expression

- \*A)  $2\text{CO}_2$
- B)  $\text{C}_2\text{O}_4$
- C)  $2\text{C}_2\text{O}$
- D)  $\text{C}_4\text{O}_2$

21) The formula for barium hydroxide octahydrate is

- \*A)  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$
- B)  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2$
- C)  $\text{BaH}_8(\text{OH})_{10}$
- D)  $\text{Ba}(\text{OH})_2(\text{H}_2\text{O})_8$

22) The formula of silver bromide is

- A) SiBr
- B) SiBr<sub>4</sub>
- \*C) AgBr
- D) AgBr<sub>2</sub>

23) The formula of sulfurous acid is

- A) SO<sub>2</sub>
- B) H<sub>2</sub>SO<sub>4</sub>
- C) H<sub>2</sub>SO<sub>2</sub>
- \*D) H<sub>2</sub>SO<sub>3</sub>

24) The formula of a metallic fluoride is XF<sub>2</sub>; the formula of the corresponding metallic phosphate is

- A) XPO<sub>4</sub>
- B) X<sub>2</sub>PO<sub>4</sub>
- C) X<sub>2</sub>(PO<sub>4</sub>)<sub>3</sub>
- \*D) X<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>

25) Which one of the following compounds is correctly named?

- \*A) Fe(ClO<sub>2</sub>)<sub>3</sub>      iron(III) chlorite
- B) PbCO<sub>3</sub>            lead(IV) carbonate
- C) Mn<sub>2</sub>S<sub>4</sub>            manganese(II) sulfide
- D) Cu<sub>2</sub>SO<sub>4</sub>          copper(I) bisulfate

26) The formula of aluminum bromide is

- A) AlBr
- B) AlBr<sub>2</sub>
- \*C) AlBr<sub>3</sub>
- D) AlBr<sub>4</sub>

12A.7.

- 27) Sand is essentially made up of a binary compound; the atomic numbers of the constituent elements of the compound are respectively, 14 and 8. The formula of the binary compound is

- A)  $\text{Li}_2\text{Be}$
- \*B)  $\text{SiO}_2$
- C)  $\text{Be}_2\text{C}$
- D)  $\text{Li}_2\text{O}$

- 28) Consider the following skeleton equation:



In the reaction of hot  $\text{Fe}_3\text{O}_4$  (magnetic iron oxide) with  $\text{H}_2(\text{g})$  (hydrogen gas) the number of moles of  $\text{H}_2\text{O}(\text{g})$  (water vapour) formed by the reaction of 3 mol of  $\text{Fe}_3\text{O}_4$  with excess  $\text{H}_2$  is

- A) 6
- \*B) 12
- C) 3
- D) 4

- 29) Which of the following equations is correctly balanced?

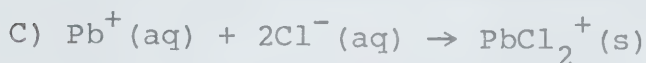
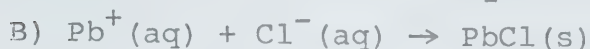
- A)  $2\text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}_2$
- B)  $\text{HgO} \rightarrow \text{Hg} + \text{O}_2$
- \*C)  $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$
- D)  $2\text{Mg} + \text{Cl}_2 \rightarrow \text{MgCl}_2$

- 30) In balancing a chemical equation, one takes account of

- A) the law of definite proportions
- \*B) the law of conservation of mass
- C) Dalton's Law
- D) the law of constant composition

12A.7.

31) The net ionic equation for the reaction between  $\text{Pb}(\text{NO}_3)_2(\text{aq})$  (lead(II) nitrate solution) and  $\text{KCl}(\text{aq})$  (potassium chloride solution) is



32) Which of the following is the correct balanced equation for the reaction of Na (sodium) and  $\text{O}_2$  (oxygen)?



33) How many moles of  $\text{CO}_2$  (carbon dioxide) are produced from the burning of 16 g of  $\text{CH}_3\text{OH}$  (methanol), according to the following equation?



12A.7.

- 34) Consider the equation for the electrolysis of  $\text{H}_2\text{O}$  (water)



The number of moles of  $\text{O}_2$  (oxygen) produced by the electrolysis of 90 g of  $\text{H}_2\text{O}$  is

- A) 1.0
- B) 2.0
- \*C) 2.5
- D) 5.0

- 35) During the electrolysis of water, hydrogen and oxygen gas are produced.



The number of moles of electrons required to reduce sufficient water to produce four moles of hydrogen gas ( $\text{H}_2$ ) is

- A) 2 moles
- B) 4 moles
- \*C) 8 moles
- D) 12 moles

- 36) How many grams of carbon dioxide are produced by burning 0.400 mol of butane ( $\text{C}_4\text{H}_{10}$ ) in excess oxygen?

- A) 4.40
- B) 17.6
- C) 44.0
- \*D) 70.4

12A.7.

37) The number of moles of  $O_2(g)$  (oxygen gas) produced by the decomposition of 54 g of  $H_2O$ , water is

- A) 0.50
- B) 2.0
- \*C) 1.5
- D) 2.5

38) Zinc (Zn) reacts with hydrochloric acid (HCl) according to the equation



The volume of  $H_2$  produced, at STP, by the reaction of 30 g of Zn with excess HCl is

- A)  $\frac{2 \times 65}{30}$  L
- B)  $\frac{2 \times 30}{65}$  L
- C)  $\frac{22.4 \times 65}{30}$  L
- \*D)  $\frac{22.4 \times 30}{65}$  L

39)  $C_2H_2$  (acetylene) burns completely in  $O_2$  (oxygen) to produce  $CO_2$  (carbon dioxide) and  $H_2O$  (water) according to the equation:



If 8.30 mol of  $C_2H_2$  are completely burned in excess oxygen, the number of moles of  $CO_2$  produced is

- A) 4.00
- B) 8.33
- C) 4.15
- \*D) 16.6

12A.7.

40) 18 g of oxygen  $O_2$  reacted with 2 g of hydrogen  $H_2$  to form water. Which of the following statements is correct?

- A) Water ( $H_2O$ ) has a relative molecular mass of 20.
- B) 18 g of O + 2 g of H  $\rightarrow$  20 g of  $H_2O$ .
- C) The Law of Multiple Proportions applies.
- \*D) Some hydrogen must have been left over.

41) What volume of dry  $O_2$  (oxygen) at STP is produced by heating 80.0 g of  $KClO_3$  (potassium chlorate).



- A) 14.6 L
- \*B) 21.9 L
- C) 22.4 L
- D) 51.5 L

42) "7 g of CO (carbon monoxide) react completely with 4 g of  $O_2$  (oxygen) yielding 11 g of  $CO_2$  (carbon dioxide)." This statement is an illustration of the

- I) Law of Multiple Proportions
- II) Law of Constant Composition
- III) Law of Conservation of Mass
- IV) Law of Combining Gas Volumes

- \*A) I and III
- B) I and IV
- C) II and III
- D) II and IV

12A.7.



How many moles of oxygen are produced during the decomposition of 8.0 mol of  $\text{KClO}_3$ ?

- A) 5.3
- \*B) 12
- C) 24
- D) 48



What volume of nitrogen reacts with 1.12 L of hydrogen to form ammonia (all gases are measured at STP)?

- \*A) 0.373 L
- B) 1.12 L
- C) 3.36 L
- D) 22.4 L

45) When gases combine chemically or are produced in a chemical reaction, there is always a simple whole number ratio between their

- A) masses
- B) densities
- \*C) volumes
- D) critical temperatures

46) Some water undergoes electrolysis and 112 mL of hydrogen gas,  $\text{H}_2(\text{g})$ , measured at STP, is released. The number of moles of water that decomposed is

- \*A)  $5 \times 10^{-3}$
- B)  $2 \times 10^{-1}$
- C) 5
- D)  $2 \times 10^2$

12A.7.

47) In which of the following pairs of anions do both names end in "ate"?

- A)  $\text{ClO}_3^-$ ,  $\text{ClO}_2^-$
- B)  $\text{NO}_3^-$ ,  $\text{NO}_2^-$
- \*C)  $\text{CO}_3^{2-}$ ,  $\text{SO}_4^{2-}$
- D)  $\text{SO}_3^{2-}$ ,  $\text{MnO}_4^-$

48) The Roman numeral which would be included in the correct name for the compound  $\text{Fe}_2\text{O}_3$  is

- A) V
- B) II
- \*C) III
- D) IV

49)  $\text{NaCl}$  (sodium chloride) reacts with  $\text{AgNO}_3$  (silver nitrate) according to the equation:



The number of moles of  $\text{AgCl}(\text{s})$  (silver chloride) formed when 0.60 mol of  $\text{NaCl}$  reacts with 0.40 mol of  $\text{AgNO}_3$  is

- A) 0.20 mol
- \*B) 0.40 mol
- C) 0.60 mol
- D) 1.0 mol

12A.7.

50) The formula for sodium thiosulfate is

- A)  $\text{Na}_2\text{SO}_4$
- B)  $\text{Na}_2\text{S}_3\text{O}_2$
- C)  $\text{Na}_2\text{SO}_3$
- \*D)  $\text{Na}_2\text{S}_2\text{O}_3$

51) The formula of aluminum nitrite is

- A)  $\text{AlNO}_3$
- B)  $\text{Al}_3\text{NO}_2$
- \*C)  $\text{Al}(\text{NO}_2)_3$
- D)  $\text{Al}(\text{NO}_3)_2$

52) The valence,  $n$ , of the dihydrogen phosphite ion ( $\text{H}_2\text{PO}_3^n$ ) is

- \*A) 1-
- B) 2-
- C) 3-
- D) 1+

53) What is the correct formula for ferric sulphate?

- A)  $\text{Fe}_2\text{S}_3$
- B)  $\text{FeSO}_4$
- C)  $\text{FeSO}_3$
- \*D)  $\text{Fe}_2(\text{SO}_4)_3$

54) Which one of the following substances has a chemical name ending in -ide?

- \*A)  $\text{TiCl}_4$
- B)  $\text{ZnSO}_4$
- C)  $\text{H}_2\text{SO}_3$
- D)  $\text{HClO}$

12A.7.

55) A compound composed of sodium, sulphur and oxygen could be named

- A) sodium peroxide
- \*B) sodium sulfate
- C) sodium sulfide
- D) sodium hydroxide

56) The name of the acid,  $\text{H}_2\text{SO}_3$ , is

- A) sulfuric
- \*B) sulfurous
- C) hydrosulfuric
- D) persulfuric

57) Which of the following is the correct formula for silver phosphite?

- A)  $\text{Ag}_3(\text{PO}_4)_2$
- B)  $\text{Ag}_3(\text{PO}_3)_2$
- C)  $\text{Ag}_3\text{PO}_4$
- \*D)  $\text{Ag}_3\text{PO}_3$

58) When the skeleton equation



is balanced with the smallest whole numbers, the coefficient of  $\text{Ca}(\text{OH})_2$  is

- A) 1
- B) 2
- \*C) 3
- D) 4

12A.7.

59) The symbol for tin is

- \*A) Sn
- B) Sb
- C) Pb
- D) Tn

60) Diethyl ether has the formula  $(C_2H_5)_2O$ . Which of one of following statements about this substance is true?

- \*A) Ether is a compound made up of three elements.
- B) Each molecule of ether is made up of 13 atoms.
- C) One mole of ether contains two moles of carbon atoms, along with other elements.
- D) One mole of ether has a mass less than 50 g.

61) Which one of the following acids has a name starting with hydro- and ending in -ic?

- A)  $H_2O$
- \*B) HBr
- C)  $HNO_3$
- D)  $HClO_4$

62) The formula for iron(III) phosphite is

- \*A)  $FePO_3$
- B)  $Fe_3PO_4$
- C)  $Fe_3(PO_4)_3$
- D)  $Fe_2(PO_4)_3$

12A.7.

63) The total number of atoms represented in the formula  $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$  is

- A) 5
- B) 8
- C) 11
- \*D) 12

64) The volume of  $\text{O}_2$  (oxygen), compared to the volume of  $\text{H}_2$  (hydrogen), produced by the electrolysis of  $\text{H}_2\text{O}$  (water) is

- \*A) 1:2
- B) 1:8
- C) 2:1
- D) 8:1

65) The correct formula for manganese(IV) oxide is

- A)  $\text{Mn}_4\text{O}$
- B)  $\text{MnO}_4$
- C)  $\text{Mn}_2\text{O}$
- \*D)  $\text{MnO}_2$

66) The formula for cuprous bromide is

- \*A)  $\text{CuBr}$
- B)  $\text{Cu}_2\text{Br}$
- C)  $\text{CuBr}_2$
- D)  $\text{Cu}_2\text{Br}_2$

12A.7.

- 67) What volume of  $\text{CO}_2$  (carbon dioxide) measured at STP will be required for the production of 159 g of  $\text{CaCO}_3$  (calcium carbonate) in the reaction described by the equation



- A) 22.4 L
- B) 32.0 L
- \*C) 35.6 L
- D) 69.9 L

- 68) The set of formulae that is correct is

- A)  $\text{Pb}_2\text{O}_5$ ,  $\text{HBr}$ ,  $\text{K}_3\text{NO}_3$
- B)  $\text{H}_2\text{O}$ ,  $\text{HClO}$ ,  $\text{CaS}_2$
- \*C)  $\text{FeCl}_3$ ,  $\text{MgS}$ ,  $\text{NaHCO}_3$
- D)  $\text{FeS}$ ,  $\text{CuCl}$ ,  $\text{CuCl}_3$

- 69) When one mole of  $\text{KClO}_3$  (potassium chlorate) decomposes to form  $\text{KCl}$  (potassium chloride) and  $\text{O}_2$  (oxygen) as its only products, the number of moles of  $\text{O}_2$  produced is

- A) 1
- \*B) 1.5
- C) 2
- D) 3

- 70) The correct formulae for potassium bromide, aluminum phosphide and silver sulfide are

- \*A)  $\text{KBr}$        $\text{AlP}$        $\text{Ag}_2\text{S}$
- B)  $\text{K}_2\text{Br}$        $\text{Al}_2\text{P}_3$        $\text{AgS}$
- C)  $\text{KBr}$        $\text{AlP}_3$        $\text{SiS}_2$
- D)  $\text{KBr}_2$        $\text{AlP}$        $\text{AgS}$

12A.7.

71) Which of the following is the formula of a "peroxide" compound?

- A)  $\text{Fe}_3\text{O}_4$
- B)  $\text{PbO}$
- \*C)  $\text{K}_2\text{O}_2$
- D)  $\text{MnO}_2$

72) The name of the compound represented by the formula  $\text{PCl}_5$  is phosphorus

- A) dichloride
- B) heptachloride
- \*C) pentachloride
- D) tetrachloride

73) If 1.00 mol of  $\text{CH}_3\text{OH}$  (methanol) is burned according to the equation:



the mass of  $\text{CO}_2$  produced is

- A) 22 g
- B) 32 g
- \*C) 44 g
- D) 88 g

12A.7.

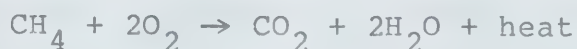
- 74) Acetone is a volatile, highly flammable liquid solvent with the formula  $\text{CH}_3\text{COCH}_3$ . When acetone burns in excess air, the balanced equation for the reaction is



The number of moles of  $\text{O}_2$  (oxygen) necessary to completely burn one mole of  $\text{CH}_3\text{COCH}_3$  is

- A) 1
- B) 2
- C) 3
- \*D) 4

- 75) Assume that a Bunsen burner is burning pure gaseous  $\text{CH}_4$  (methane) with sufficient oxygen to form the products  $\text{CO}_2$  (carbon dioxide gas) and  $\text{H}_2\text{O}$  (water) according to the following equation



How many moles of  $\text{H}_2\text{O}$  will be produced by the complete combustion of 8.0 g of  $\text{CH}_4$ ?

- \*A) 1.0
- B) 2.0
- C) 0.50
- D) 18

- 76) The symbol for the element silver is

- A) S
- B) Au
- C) Si
- \*D) Ag

12A.7.

77) Which one of the following formulae is correct?

- A)  $\text{Al}_3(\text{SO}_4)_2$
- \*B)  $\text{LiH}$
- C)  $\text{NH}_4\text{SO}_4$
- D)  $\text{BaHCO}_3$

78) When the following equation is balanced



the coefficient of the NaOH (sodium hydroxide) is

- \*A) 1
- B) 2
- C) 3
- D) 4

79) Atoms of element A have 2 electrons in their highest occupied energy level. Atoms of element B have 7 electrons in their highest occupied energy level. The formula of the compound formed between A and B is

- A)  $\text{AB}_3$
- B)  $\text{A}_2\text{B}$
- \*C)  $\text{AB}_2$
- D)  $\text{A}_7\text{B}_2$

80) The formula of barium peroxide is

- \*A)  $\text{BaO}_2$
- B)  $\text{BaO}$
- C)  $\text{Ba}_2\text{O}$
- D)  $\text{Ba}_2\text{O}_2$

12A.7.

81) 25 mL of  $\text{H}_2$  (hydrogen) and 20 mL of  $\text{O}_2$  (oxygen) are placed in a eudiometer. After the mixture has been exploded by means of an electric spark the volume of gas remaining in the eudiometer is approximately

- A) 5.0 mL
- \*B) 7.5 mL
- C) 10 mL
- D) 14 mL

82) The formula of copper(II) sulfate pentahydrate is

- A)  $\text{CuSO}_4$
- B)  $\text{CuSO}_4 \cdot 3\text{H}_2\text{O}$
- \*C)  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
- D)  $\text{CuSO}_4 \cdot 6\text{H}_2\text{O}$

83) A compound with the chemical formula  $\text{SnCl}_4$  is be named

- A) tin chloride
- B) stannous(IV) chloride
- \*C) tin(IV) chloride
- D) stannous chloride

84)  $\text{H}_2(\text{g})$  (hydrogen gas) reduces hot  $\text{Fe}_3\text{O}_4$  (magnetic iron oxide) to  $\text{Fe}(\text{s})$  (iron metal) according to the equation:



The number of moles of water formed by passing dry  $\text{H}_2$  over 464 g of  $\text{Fe}_3\text{O}_4$  until reduction is completed is

- \*A) 8.0
- B) 2.0
- C) 16
- D) 4.0

12A.7.

- 85) Hydrogen gas reacts with hot copper(II) oxide according to the equation:



The number of moles of water formed when 159 g of CuO are completely reduced to copper metal is

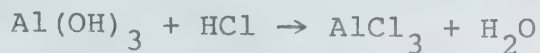
- A) 1.00
  - \*B) 2.00
  - C) 1.50
  - D) 1.59
- 86) An oxy-acid is a compound which
- A) is usually a basic compound
  - B) turns litmus from red to blue
  - \*C) contains at least three elements
  - D) is a binary compound
- 87) Which one of the following will need to gain the smallest number of electrons to achieve a stable octet formation?
- A) magnesium
  - B) nitrogen
  - C) aluminum
  - \*D) oxygen





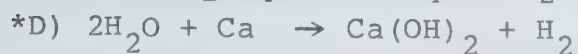
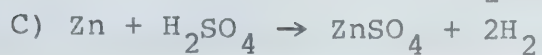
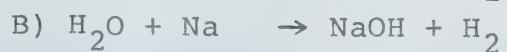
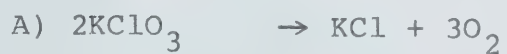
12A.7.

- 88) The unbalanced equation representing the neutralization of  $\text{Al}(\text{OH})_3$  (aluminum hydroxide) with  $\text{HCl}$  (hydrochloric acid) is:



When the equation is balanced with the smallest whole-numbers, the coefficient of  $\text{HCl}$  is

- A) 1
  - B) 2
  - \*C) 3
  - D) 4
- 89) The symbol for the element silicon is
- A) S
  - B) Na
  - \*C) Si
  - D) Ag
- 90) Which one of the following equations is balanced?



12A.7.

- 91) The ratio of the volume of  $N_2$  (nitrogen) consumed to  $NH_3$  (ammonia) produced in the reaction



is

- \*A) 1:2
- B) 1:3
- C) 3:2
- D) 2:3

- 92) 8.0 g of methanol ( $CH_3OH$ ) are completely burned according to the equation:



The number of moles of water ( $H_2O$ ) produced is

- A) 1
- B) 1/8
- C) 1/4
- \*D) 1/2

- 93) The name corresponding to the formula  $Fe(H_2PO_3)_2$  is

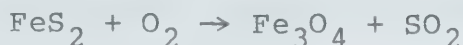
- A) ferrous biphosphite
- \*B) ferrous dihydrogen phosphite
- C) ferric dihydrogen phosphite
- D) ferric biphosphite

- 94) The name corresponding to the formula  $Na_2CO_3 \cdot 10H_2O$  is

- A) sodium carbonate hydrate
- B) disodium carbonite decahydrate
- \*C) sodium carbonate decahydrate
- D) disodium carbonate heptahydrate

12A.7.

- 95) When the following equation is balanced, the coefficients, in order from left to right, are



- A) 3, 4, 1, 2
- B) 1, 3, 1, 2
- C) 3, 8, 0, 2
- \*D) 3, 8, 1, 6

- 96) 0.250 mol of methanol ( $\text{CH}_3\text{OH}$ ) is completely burned according to the equation:



What volume of carbon dioxide ( $\text{CO}_2$ ) (measured at 298 K and 101 kPa pressure) is produced?

- \*A) 6.11 L
- B) 22.4 L
- C) 44.8 L
- D) 48.9 L

- 97) When a piece of warm white phosphorus is dropped into a container of chlorine ( $\text{Cl}_2$ ) the products of reaction are

- A)  $\text{PCl}$  and  $\text{PCl}_3$
- B)  $\text{PCl}_2$  and  $\text{PCl}_3$
- \*C)  $\text{PCl}_3$  and  $\text{PCl}_5$
- D)  $\text{PCl}$  and  $\text{PCl}_5$

- 98) The name of a chemical compound ends in "ide"; the compound is

- A) acidic
- \*B) binary
- C) basic
- D) an oxide

12A.7.

99) Given the equation:



How many moles of fluorine ( $\text{F}_2$ ) are required to form 3 mol of krypton hexafluoride ( $\text{KrF}_6$ )?

- A) 1
- B) 1/3
- C) 3
- \*D) 9

100) If the name of an acidic substance has the ending ....ic acid, then the formula for the per.....ic acid of the same family is obtained by

- A) removing all the oxygen atoms
- \*B) adding one oxygen atom
- C) subtracting one hydrogen atom
- D) subtracting one oxygen atom

101) Hydrogen ( $\text{H}_2$ ) and oxygen ( $\text{O}_2$ ) combine to form water ( $\text{H}_2\text{O}$ ) according to the equation



The volume ratio in which  $\text{H}_2$  combines with  $\text{O}_2$  is

- A) 1:1
- B) 1:2
- \*C) 2:1
- D) 1:8

12A.7.

102) Consider the equation:



The number of moles of hydrogen ( $\text{H}_2$ ) required to completely react with three moles of iron oxide ( $\text{Fe}_3\text{O}_4$ ) is

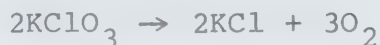
- A) 9
- \*B) 12
- C) 3
- D) 4

103) The name corresponding to the formula  $\text{Fe}(\text{ClO}_4)_2$  is

- A) iron(II) chlorate
- \*B) iron(II) perchlorate
- C) iron dichlorate
- D) iron(III) perchlorate

12A.7.

- 104) What volume of dry oxygen, at STP, can be obtained by heating 245 g of potassium chlorate ( $\text{KClO}_3$ )?



- A) 22.4 L
- \*B) 67.2 L
- C) 245 L
- D) 490 L

- 105) The net ionic equation for the reaction between Mg (magnesium) and dilute  $\text{HCl(aq)}$  (hydrochloric acid) is

- A)  $2\text{Mg(s)} + 2\text{H}^+(\text{aq}) \rightarrow 2\text{Mg}^+(\text{aq}) + \text{H}_2(\text{g})$
- B)  $\text{Mg(s)} + \text{H}^{2+}(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{H(g)}$
- \*C)  $\text{Mg(s)} + 2\text{H}^+(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{H}_2(\text{g})$
- D)  $\text{Mg}^{2+}(\text{aq}) + \text{H}_2(\text{g}) \rightarrow \text{Mg(s)} + 2\text{H}^+(\text{aq})$

- 106) How many grams of phosphorus can be obtained by the decomposition of  $1.5 \times 10^5$  g of calcium phosphate,  $\text{Ca}_3(\text{PO}_4)_2$ ? (Assume that all the phosphorus is obtainable)

- A) 30 g
- B)  $2.7 \times 10^3$  g
- C)  $1.5 \times 10^4$  g
- \*D)  $3.0 \times 10^4$  g

- 107) The formula of barium sulphate is

- A)  $\text{Ba}_2\text{SO}_3$
- \*B)  $\text{BaSO}_4$
- C)  $\text{BaSO}_2$
- D)  $\text{Ba}_3(\text{SO}_4)_2$

12A.7.

108) The name of the compound with the formula  $\text{PbCO}_3$  is

- \*A) lead(II) carbonate
- B) lead(IV) carbonate
- C) lead dicarbonate
- D) lead(III) carbonide

109) The name of the compound with the formula  $\text{Na}_2\text{SO}_3$  is

- A) sodium sulfide
- B) sodium sulfate
- \*C) sodium sulfite
- D) sodium sulfur trioxide

110) The formula of hydrogen peroxide is

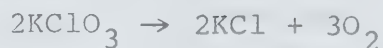
- A) HO
- B)  $\text{H}_2\text{O}$
- \*C)  $\text{H}_2\text{O}_2$
- D)  $\text{HO}_2$

111) Which one of the following symbols represents a metal?

- A) P
- \*B) K
- C) S
- D) I

12A.7.

112) In the reaction described by the equation:



the number of moles of  $\text{KClO}_3$  (potassium chlorate) required to produce one mole of  $\text{O}_2$  (oxygen) is

- \*A) 0.67
- B) 2.0
- C) 3.0
- D) 1.5

113) What volume of  $\text{H}_2$  (hydrogen), at STP, is produced by the reaction of 1.00 mol of Al (aluminum) with excess HCl (hydrochloric acid)?



- A) 1.00 x 22.4 L
- \*B) 1.50 x 22.4 L
- C) 2.00 x 22.4 L
- D) 3.00 x 22.4 L

114) The atomic number of element X is 3 and the atomic number of element Y is 8. The formula of the compound formed by the combination of elements X and Y is

- A)  $\text{X}_3\text{Y}_8$
- B)  $\text{X}_6\text{Y}_{21}$
- \*C)  $\text{X}_2\text{Y}$
- D)  $\text{Y}_2\text{X}$

12A.7.

115) The formula of the binary compound formed between calcium and phosphorus is

- \*A)  $\text{Ca}_3\text{P}_2$
- B)  $\text{Ca}_3\text{PO}_4$
- C)  $\text{Ca}_5\text{P}$
- D)  $\text{Ca}_4\text{P}_2$

116) The reaction between  $\text{H}_2$  (hydrogen) and  $\text{O}_2$  (oxygen) is:



The mass of  $\text{O}_2$  required to completely convert 4.0 g of  $\text{H}_2$  to water is

- A) 8.0 g
- B) 2.0 g
- C) 16 g
- \*D) 32 g

117) Methanol burns according to the equation:



The total mass of the products formed when 1 mol of methanol is burned in oxygen is

- A) 67.2 g
- \*B) 80.0 g
- C) 134.4 g
- D) 160 g

12A.7.

- 118) The maximum yield of copper obtained from the reduction of 795 g of CuO (copper(II) oxide) by dry H<sub>2</sub> (hydrogen) according to the equation



is

- A) 63.5 x 1 g
- \*B) 63.5 x 10 g
- C) 63.5 x 22.4 g
- D) 63.5 x 18 g

- 119) The formula of iron(II) oxide is

- \*A) FeO
- B) Fe<sub>2</sub>O<sub>3</sub>
- C) FeO<sub>2</sub>
- D) Fe<sub>2</sub>O

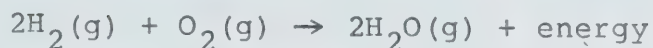
- 120) What mass of CaCO<sub>3</sub> (calcium carbonate) is required to produce 84 g of CaO (calcium oxide)?



- A) 66.6 g
- B) 84.0 g
- C) 100 g
- \*D) 150 g

12A.7.

121) Consider the following balanced chemical equation:



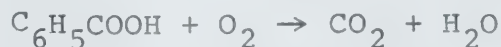
The number of moles of  $\text{H}_2\text{O}$  (water) produced by the complete combustion of 4 mol of  $\text{H}_2(\text{g})$  (hydrogen gas) is

- A) 1
- B) 2
- C) 8
- \*D) 4

122) The symbol of the plumbous ion is

- A)  $\text{Pl}^+$
- \*B)  $\text{Pb}^{2+}$
- C)  $\text{Pl}^{2+}$
- D)  $\text{Pb}^{4+}$

123) The chemical formula of a component of candle wax is  $\text{C}_6\text{H}_5\text{COOH}$ . It burns according to the unbalanced equation:



When the equation is balanced for 1 mol of  $\text{C}_6\text{H}_5\text{COOH}$  the coefficient for oxygen is

- A) 6
- B)  $6\frac{1}{2}$
- \*C)  $7\frac{1}{2}$
- D) 14

12A.7.

- 124) A strip of Zn (metallic zinc) was weighed and placed in a beaker containing a solution of  $\text{AgNO}_3$  (silver nitrate). The next day, a silvery metallic deposit was present in the beaker. The zinc strip was washed, dried and weighed. The liquid was poured off and the metallic residue was also washed, dried and weighed. The data obtained are recorded below:

Mass of zinc strip before reaction	14.26 g
Mass of zinc strip after reaction	13.61 g
Mass of silver produced	2.16 g



When the equation is balanced the coefficients for the substances in the equation given above are, in order of appearance

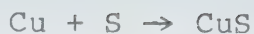
- A) 1, 1, 1, 1
- B) 2, 1, 1, 2
- \*C) 1, 2, 2, 1
- D) 1, 3, 3, 1

- 125) If the zinc strip referred to in question 1606 had been replaced with a magnesium strip, the mass of magnesium consumed would have been

- \*A) 0.242 g
- B) 0.325 g
- C) 0.650 g
- D) 2.16 g

12A.7.

126) Consider the equation:



How many kilograms of copper are required to produce 32 kg of copper(II) sulphide?

- \*A) 21 kg
- B) 32 kg
- C) 64 kg
- D) 96 kg

127)



How many grams of aluminum are needed to react completely with 40.0 g of iron(III) oxide?

- A) 6.75 g
- \*B) 13.5 g
- C) 54.0 g
- D) 216.0 g

128) If  $\text{XF}_2$  is the correct formula for a metallic fluoride, then the formula for the oxide of X is

- A)  $\text{X}_2\text{O}$
- \*B)  $\text{XO}$
- C)  $\text{XO}_4$
- D)  $\text{XO}_2$

129) The name corresponding to the formula  $\text{NH}_4\text{H}_2\text{PO}_4$ , is

- A) ammonium dihydrogen phosphite
- \*B) ammonium dihydrogen phosphate
- C) ammonium hydrogen phosphate
- D) diammonium hydrogen phosphate

12A.7.

130) Phosphorus,  $P_4$ , burns in air to form the oxide,  $P_4O_{10}$ .  
The balanced equation for the reaction is

- A)  $P_4 + 10 O \rightarrow P_4O_{10}$
- \*B)  $P_4 + 5 O_2 \rightarrow P_4O_{10}$
- C)  $4P + 10 O \rightarrow P_4O_{10}$
- D)  $P_4 + 5 O_2 \rightarrow 2P_4O_{10}$

131) Element X has a valence of 2, and element Y has a valence of 3. The formula of the binary compound made up of these two elements is

- A)  $XY_2$
- B)  $XY_3$
- C)  $X_2Y_3$
- \*D)  $X_3Y_2$

132) The following equation is unbalanced:

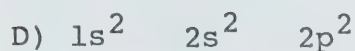
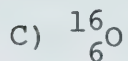
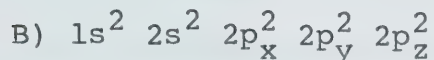


When the equation is balanced the sum of the four coefficients in the equation is

- A) 6
- B) 9
- C) 10
- \*D) 12

12A.7.

133) Which one of the following representations describes the electronic configuration of an atom of oxygen?



134) Consider the equation



How many moles of  $\text{MnO}_2$  (manganese(IV) oxide) are necessary to produce two molar volumes of  $\text{Cl}_2(\text{g})$  (chlorine gas)?

A) 1

\*B) 2

C)  $\frac{1}{2}$

D) 8

135) What will be the total volume of products formed (measured at STP) when 19 g of  $\text{CS}_2$  (carbon disulfide) are burned according to the following equation?



A) 5.6 L

B) 11.2 L

\*C) 16.8 L

D) 29.9 L

12A.7.

136) A metallic chloride has the formula  $MCl_2$ . The formula for the phosphide compound of element M is expected to be

- A)  $MP$
- B)  $M_2P_3$
- C)  $M_2P$
- \*D)  $M_3P_2$

137) An atom of element X has 11 electrons and an atom of element Y has 8 electrons. The formula of the product of the reaction of these elements is expected to be

- A)  $XY$
- \*B)  $X_2Y$
- C)  $XY_2$
- D)  $X_2Y_3$

138) Aluminum chloride is represented by the formula

- A)  $AlCl_2$
- \*B)  $AlCl_3$
- C)  $Al(ClO)_3$
- D)  $Al(ClO_2)$

139) Which of the following compounds is correctly named?

- A)  $Fe_2O_3$  iron(II) oxide
- \*B)  $H_2SO_4$  sulfuric acid
- C)  $AgNO_3$  silver nitride
- D)  $MgSO_3$  magnesium sulfate

12A.7.

140) Which of the following sets of entries (name, formula and relative molecular mass) is completely correct?

NAME	FORMULA	RELATIVE MOLECULAR MASS
A) dihydrogen oxide	H <sub>2</sub> O	36.0
B) dinitrogen tetroxide	N <sub>2</sub> O <sub>4</sub>	100.0
*C) carbon tetrafluoride	CF <sub>4</sub>	88.0
D) carbon disulfide	CS <sub>2</sub>	44.0

141) What volume of O<sub>2</sub> (oxygen) at STP is needed to burn 16 g of CH<sub>3</sub>OH (methanol), according to the following equation?



- \*A) 0.75 x 22.4 L
- B) 1.5 x 22.4 L
- C) 3 x 22.4 L
- D) 6 x 22.4 L

142) The element with atomic number 10 usually exhibits a valence of

- \*A) 0
- B) -2
- C) +2
- D) -4

12A.7.

- 143) 5.0 L of  $\text{N}_2$  (nitrogen gas) is allowed to react completely with excess  $\text{H}_2$  (hydrogen) according to the equation.



If all the gases are measured at the same temperature and pressure, the volume of ammonia gas,  $\text{NH}_3$ , produced is

- A) 5.0 L
- B) 8.0 L
- \*C) 10 L
- D) 20 L

- 144) Consider the equation:



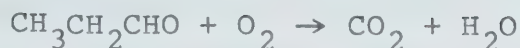
"20 mL of carbon monoxide,  $\text{CO}$ , and 10 mL of oxygen,  $\text{O}_2$ , react forming 20 mL of carbon dioxide,  $\text{CO}_2$ ." This statement illustrates all of the following EXCEPT

- I) Avogadro's Principle
- II) Law of Multiple Proportions
- III) Boyle's Law
- IV) Gay-Lussac's Law of Combining Gas Volumes

- A) I
- B) II
- \*C) III
- D) IV

12A.7.

145) Consider the unbalanced equation



Which one of the following sets of coefficients balances the equation

- A) 2, 8, 3, 6
- B) 3, 8, 6, 6
- C) 1, 8, 3, 3
- \*D) 1, 4, 3, 3

146) A metallic element X forms a carbonate with the formula  $\text{X}(\text{CO}_3)_2$ . The corresponding fluoride compound of element X would have the formula

- A)  $\text{XF}$
- B)  $\text{XF}_2$
- C)  $\text{X}_4\text{F}$
- \*D)  $\text{XF}_4$

147) Hydrogen,  $\text{H}_2$ , and oxygen,  $\text{O}_2$ , gases combine to form water vapour according to the following equation:



Provided that the pressure and temperature are such that water is gaseous, the volume ratio of  $\text{H}_2$  consumed to  $\text{H}_2\text{O}$  produced is

- \*A) 1:1
- B) 8:1
- C) 2:1
- D) 4:1

12A.7.

148) What volume of hydrogen sulphide ( $\text{H}_2\text{S}$ ) at S.T.P. is produced if an excess of hydrochloric acid ( $\text{HCl}$ ) is added to 5.50 g of iron(II) sulfide ( $\text{FeS}$ )

- \*A) 1.40 L
- B) 4.07 L
- C) 22.4 L
- D) 44.8 L

149) How many moles of carbon dioxide ( $\text{CO}_2$ ) are produced when 1.0 mole of propanol ( $\text{C}_3\text{H}_7\text{OH}$ ) burns completely in oxygen? Assume that  $\text{CO}_2$  (carbon dioxide) and ( $\text{H}_2\text{O}$ ) water are the only products.

- A) 1.0
- B) 2.0
- \*C) 3.0
- D) 4.0

150) Nitrogen gas ( $\text{N}_2$ ) and hydrogen gas ( $\text{H}_2$ ) react to produce ammonia ( $\text{NH}_3$ ) according to the following balanced equation:



How many litres of hydrogen gas ( $\text{H}_2$ ) measured at 100 kPa and 273 K are required to react with 11.2 L of nitrogen gas,  $\text{N}_2$ , measured at 100 kPa and 273 K?

- A) 16.8
- B) 22.4
- \*C) 33.6
- D) 67.2

12A.7.

151) Which of the following sets of formulae contains an INCORRECT formula?

- A)  $\text{KClO}$ ,  $\text{H}_2\text{SO}_3$ ,  $\text{PbCl}_2$
- B)  $\text{Fe}_2(\text{CO}_3)_3$ ,  $\text{H}_2\text{O}_2$ ,  $\text{AgI}$
- C)  $\text{Ca}(\text{HCO}_3)_2$ ,  $\text{CuBr}$ ,  $\text{CuBr}_2$
- \*D)  $\text{H}_2\text{Cl}$ ,  $\text{Na}_2\text{CO}_3$ ,  $\text{Br}_2$

152) The volume of uncombined gas remaining after exploding a mixture of 4 mL of hydrogen gas and 16 mL of oxygen gas is (all volumes recorded at S.T.P.)

- A) 0 mL
- B) 8 mL
- C) 12 mL
- \*D) 14 mL

153) Select the group which has the correct formulas for the oxides of sodium, magnesium and aluminium.

- A)  $\text{SO}_2$       $\text{MgO}_3$       $\text{Al}_2\text{O}$
- \*B)  $\text{Na}_2\text{O}$       $\text{MgO}$       $\text{Al}_2\text{O}_3$
- C)  $\text{Na}_2\text{O}$       $\text{MnO}$       $\text{A}_2\text{O}_3$
- D)  $\text{SoO}_2$       $\text{MgO}$       $\text{Am}_2\text{O}_3$

154) The symbol for the element silver is

- A) S
- B) Au
- C) Si
- \*D) Ag

12A.7.

155) The name of the substance represented by  $\text{Ca}(\text{NO}_2)_2$  is

- A) calcium nitrous
- B) calcium nitrate
- C) calcium nitride
- \*D) calcium nitrite

156) The name of the substance represented by the formula  $\text{NaHCO}_3$  is

- \*A) sodium hydrogen carbonate
- B) sodium hydrogen carbonite
- C) sodium carbonate
- D) sodium carbide

157) The correct name for  $\text{Na}_2\text{SO}_3$  is

- A) sodium persulfate
- \*B) sodium sulfite
- C) sodium sulfate
- D) sodium sulfur hyposulfate

158) The name of the substance represented by  $\text{Mg}_3(\text{PO}_3)_2$  is

- \*A) magnesium phosphite
- B) magnesium phosphate
- C) manganese(II) phosphite
- D) manganese(II) phosphate

159) The formula of iron(III) sulphite is

- \*A)  $\text{Fe}_2(\text{SO}_3)_3$
- B)  $\text{Fe}_2(\text{SO}_2)_3$
- C)  $\text{Fe}_2(\text{SO}_4)_3$
- D)  $\text{Fe}_3(\text{SO}_3)_2$

12A.7.

160)  $\text{NH}_4\text{ClO}_3$  is called

- A) ammonium trichlorate
- B) ammonium perchlorate
- \*C) ammonium chlorate
- D) ammonium chlorite

161) The name of the substance represented by the formula  $\text{NaClO}$  is

- A) sodium chlorite
- \*B) sodium hypochlorite
- C) sodium chlorate
- D) sodium perchlorate

162) An aqueous solution of hydrogen sulphate is called

- A) thiosulphuric acid
- \*B) sulphuric acid
- C) hydrosulphuric acid
- D) sulphurous acid

163) The name of the compound represented by the formula  $\text{Na}_2\text{O}_2$  is

- A) disodium oxide
- B) sodium dioxide
- C) sodium(IV) oxide
- \*D) sodium peroxide

12A.7.

164) The name of the substance represented by the formula  $(\text{NH}_4)_3\text{PO}_3$ , is ammonium

- A) phosphate
- B) hypophosphite
- \*C) phosphite
- D) (III) perphosphate

165) The formula for an oxide is  $\text{X}_2\text{O}_5$ ; the valence of X in this oxide is

- A) -5
- B) +2
- \*C) +3
- D) -10

166) 26.9 g of a hydrate,  $\text{BaSO}_4 \cdot \underline{\text{X}}\text{H}_2\text{O}$ , is heated and produces 23.3 g of the anhydrous salt and the appropriate mass of water vapour. The value of X is

- A) 5
- \*B) 2
- C) 3
- D) 6

167) The elements in group VI are oxygen, sulfur, selenium and tellurium. The formula of hydrogen telluride is

- \*A)  $\text{H}_2\text{Te}$
- B)  $\text{HTe}_2$
- C)  $\text{HTe}$
- D)  $\text{H}_2\text{Te}_3$

12A.7.

168) A metallic element "M" reacts with oxygen to form an oxide whose formula is  $M_2O_3$ . The formula of the corresponding chloride of the metal will be

- \*A)  $MCl_3$
- B)  $MCl$
- C)  $MCl_2$
- D)  $M_2Cl$

169) Which of the following compounds is most likely to exist under standard conditions of temperature and pressure?

- \*A)  $Al_2O_3$
- B)  $MgNe_2$
- C)  $NaO_2$
- D)  $BaO_3$

170) Hydrogen and oxygen gases combine to form water vapour according to this equation:



Provided the pressure and temperature are such that water is gaseous, the volume ratio of hydrogen consumed to water vapour produced is

- \*A) 1:1
- B) 8:1
- C) 2:1
- D) 1:2

12A.7.

171) Ethane,  $C_2H_6$ , burns in air according to the following balanced equation:



How many moles of oxygen ( $O_2$ ) are required to produce 22 g of carbon dioxide ( $CO_2$ )?

A)  $\frac{7}{22}$

\*B)  $\frac{7}{8}$

C)  $\frac{8}{7}$

D)  $\frac{7}{2}$

172)



When this equation is balanced the coefficient of  $O_2$  is

A)  $\frac{3}{2}$

B) 2

\*C) 3

D) 4

173) When the equation



is balanced, the coefficient of carbon dioxide is

A) 1

B) 2

\*C) 3

D) 4

12A.7.

- 174) How many moles of carbon dioxide ( $\text{CO}_2$ ) are produced when 46 g of  $\text{C}_2\text{H}_5\text{OH}$  (ethanol) is completely burned in oxygen? Assume that  $\text{CO}_2$  and  $\text{H}_2\text{O}$  are the only products.

- A) 1.0 mol  $\text{CO}_2$
- \*B) 2.0 mol  $\text{CO}_2$
- C) 0.5 mol  $\text{CO}_2$
- D) 1.5 mol  $\text{CO}_2$

- 175) When 10 mol of potassium chlorate ( $\text{KClO}_3$ ) is completely decomposed by heating,



the number of moles of oxygen produced is

- A) 3
- B) 10
- \*C) 15
- D) 30

- 176) What volume of oxygen will combine with 11.2 mL of hydrogen to form water (both gases being measured at the same temperature and pressure)?

- \*A) 5.6 mL
- B) 11.2 mL
- C) 22.4 mL
- D) 44.8 mL

12A.7.

- 177) The reduction of heated magnetic iron oxide by hydrogen gas is represented by the UNBALANCED equation:



How many moles of water vapour ( $\text{H}_2\text{O}$ ) can be formed by the complete reaction of 3 mol of magnetic iron oxide?

- A) 6 mol
- \*B) 12 mol
- C) 3 mol
- D) 8 mol

- 178) The unbalanced equation representing the neutralization of aluminum hydroxide with hydrochloric acid is.



The coefficient of HCl in the balanced equation is

- A) 1
- B) 2
- \*C) 3
- D) 6

- 179) When the following equation is balanced, for one mole of formaldehyde ( $\text{HCHO}$ ), the sum of the coefficients is



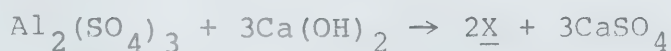
- A) 7
- B) 6
- C) 5
- \*D) 4

12A.7.

180) One mole of potassium chlorate decomposes to form potassium chloride and oxygen as the only products. The number of moles of oxygen produced is

- A) 1.0
- B) 2.0
- C) 3.0
- \*D) 1.5

181) In the balanced equation:



the "X" represents

- A)  $\text{H}_2\text{O}$
- B) Al
- \*C)  $\text{Al}(\text{OH})_3$
- D)  $\text{Al}_2(\text{OH})_3$

182) Nitrogen gas ( $\text{N}_2$ ) and hydrogen gas ( $\text{H}_2$ ) react to produce ammonia ( $\text{NH}_3$ ) according to the following balanced equation:



How many litres of hydrogen gas ( $\text{H}_2$ ) measured at 100 kPa and 273 K are required to react completely with 11.2 L of nitrogen gas ( $\text{N}_2$ ) measured at 100 kPa and 273 K?

- A) 16.8 L
- B) 22.4 L
- \*C) 33.6 L
- D) 67.2 L

12A.7.

- 183) Hydrogen and oxygen gases combine to form water vapour according to the equation.



The volume ratio in which hydrogen combines with oxygen is (hydrogen : oxygen)

- \*A) 2:1
- B) 1:1
- C) 8:1
- D) 1:2

- 184) Carbon disulphide ( $\text{CS}_2$ ) burns in air; the reaction is described by the following equation:



How many moles of oxygen are required to produce 11 g of carbon dioxide ( $\text{CO}_2$ ) ?

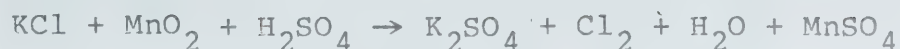
- A)  $\frac{3}{11}$  mol
- \*B)  $\frac{3}{4}$  mol
- C)  $\frac{4}{3}$  mol
- D) 3 mol

- 185) How many moles of carbon dioxide ( $\text{CO}_2$ ) are produced when one mole of ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ) is burned completely in oxygen

- A) 1.0
- \*B) 2.0
- C) 3.0
- D) 4.0

12A.7.

- 186) The sum of the coefficients when the following equation is balanced is:



- A) 8
- B) 9
- \*C) 10
- D) 14

- 187) The volume of oxygen gas, at STP, required for the complete combustion of 1.00 mol of ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , is

- A) 11.2 L
- B) 22.4 L
- C) 44.8 L
- \*D) 67.2 L

- 188) Calcium carbonate decomposes on heating to yield carbon dioxide ( $\text{CO}_2$ ) and quicklime ( $\text{CaO}$ ):



What mass of calcium carbonate ( $\text{CaCO}_3$ ) would be required to produce 168 kg of quicklime ( $\text{CaO}$ )?

- A)  $100 \times \frac{56}{168}$  kg
- B)  $\frac{168}{2}$  kg
- C) 168 kg
- \*D)  $100 \times \frac{168}{56}$  kg

12A.7.

189) What volume of 6.00 mol/L nitric acid,  $\text{HNO}_3(\text{aq})$ , solution is needed to make 4.2 L of 0.15 mol/L  $\text{HNO}_3$  solution?

- A) 1.05 L
- B) 168 mL
- \*C) 105 mL
- D) 214 mL

190)  $\text{MF}_3$  is the formula for a metallic fluoride. What is the formula for the oxide of M

- A)  $\text{M}_2\text{O}$
- \*B)  $\text{M}_2\text{O}_3$
- C)  $\text{MO}$
- D)  $\text{MO}_2$

12A.8.

- 1) The behaviour of water on freezing is unusual in that it
  - A) forms a solid
  - B) forms a solid having intermolecular forces
  - \*C) forms a solid in which the molecules are further apart than they are in the liquid
  - D) produces a solid which exhibits closer packing of molecules than its liquid
  
- 2) Liquid water at  $-5^{\circ}\text{C}$  is said to be
  - \*A) supercooled
  - B) undercooled
  - C) at equilibrium
  - D) overcooled
  
- 3) The process by which the water of crystallization is driven off from a hydrated crystal by heating is called
  - \*A) dehydration
  - B) decrepitation
  - C) condensation
  - D) deliquescence
  
- 4) Gypsum, borax, bluestone and Epsom salts have one property in common; they are all
  - A) compounds of copper
  - B) basic
  - \*C) hydrates
  - D) carbonate compounds

12A.8.

5) As ice melts and the water thus formed is heated, its density

- A) increases steadily
- B) decreases steadily
- \*C) increases to  $4^{\circ}\text{C}$  and then decreases
- D) decreases to  $4^{\circ}\text{C}$  and then increases

6) Aluminum chloride forms a hydrate with the formula  $\text{Al}_2\text{Cl}_6 \cdot n\text{H}_2\text{O}$ . The substance was analysed to determine the value of  $n$ . During the analysis the crucible and the aluminum chloride sample were heated "to constant mass".

Data:	Mass of crucible	=	22.54 g
	Mass of crucible and hydrate	=	31.44 g
	Mass of crucible and residue		
	after heating	=	27.84 g

The value of  $n$  is

- A) 6
- B) 3
- \*C) 10
- D) 4

7) A hydrate which loses water on standing is said to be

- A) deliquescent
- \*B) efflorescent
- C) hygroscopic
- D) supersaturated

8) A hydrate is a(n)

- A) mixture
- B) element
- \*C) compound
- D) solution

12A.8.

- 9) Sodium thiosulfate is a hydrate. It will lose the greatest amount of its water of hydration if it is left in a
- A) sample of very humid air
  - B) tightly stoppered jar
  - \*C) desiccator
  - D) cool, damp cellar
- 10) Crystals of a compound, when exposed to air, become dull and chalk-like in appearance. This change is due to the process of
- A) sublimation
  - \*B) efflorescence
  - C) deliquescence
  - D) hydration
- 11) Compounds which become wet and dissolve upon exposure to air are said to be
- \*A) deliquescent
  - B) efflorescent
  - C) binary
  - D) anhydrous
- 12) A solution that contains more solute than can normally be dissolved in the solvent at a particular temperature is called
- A) unsaturated
  - B) saturated
  - \*C) supersaturated
  - D) polyunsaturated

12A.8.

13) A mixture of 50 g of water and 50 g of common salt (solubility, 35 g/100 g of water) is well shaken. When stirring produces no more changes the reaction vessel will contain

- A) a solution phase only
- B) water and salt phases
- \*C) solution and salt phases
- D) a salt phase only

14) A reaction vessel which holds a saturated solution of common salt in water plus excess salt, contains

- A) 1 phase
- \*B) 2 phases
- C) 3 phases
- D) 4 phases

15) Sugar is dissolved in water. The sugar and water are respectively the

- A) solvent and solution
- \*B) solute and solvent
- C) solution and solute
- D) solute and solution

16) A true solution is always

- A) heterogeneous
- \*B) homogeneous
- C) coloured
- D) clear

12A.8.

17) A crystal of solute is added to an aqueous solution of the same solute. After some time it is noted that the crystal has not changed in mass. Which statement is true?

- A) The solute is insoluble in water.
- B) The solute is slightly soluble in water.
- \*C) The original solution was saturated.
- D) The original solution was supersaturated.

18) The concentration of a solution containing 4 g of NaOH (sodium hydroxide) in 100 mL of solution is

- \*A) 1 mol/L
- B) 2 mol L
- C) 3 mol/L
- D) 4 mol/L

19) The solubility of NaCl (sodium chloride), in water at 288 K, is 35.0 g per 100 g of water. The mass of NaCl in 270 g of saturated solution is

- A) 35.0 g
- \*B) 70.0 g
- C) 94.5 g
- D) 275 g

20)  $\text{CCl}_4$  (carbon tetrachloride) tends to dissolve

- A) electrovalent compounds
- B) salts
- C) polar solutes
- \*D) non-polar solutes

- 21) 20 mL of 9.0 mol/L sulphuric acid is diluted to a total volume of 3.0 L. The concentration of the dilute solution is
- \*A) 0.060 mol/L
  - B) 0.12 mol/L
  - C) 0.60 mol/L
  - D) 3.0 mol/L
- 22) 49 g of  $\text{H}_2\text{SO}_4$  is dissolved in sufficient water to make 250 mL of solution; the concentration of the resulting solution is
- A) 0.13 mol/L
  - \*B) 2.0 mol/L
  - C) 0.50 mol/L
  - D) 4.0 mol/L
- 23) A saturated solution of  $\text{KNO}_3$  (potassium nitrate) may be made unsaturated by
- \*A) raising the temperature
  - B) raising the pressure
  - C) adding a crystal of potassium nitrate
  - D) evaporating some of the water
- 24) What volume of 5.0 mol/L HCl (hydrochloric acid) is needed to prepare 400 mL of 0.25 mol/L HCl solution?
- \*A) 20 mL
  - B) 2.0 mL
  - C) 40 mL
  - D) 4.0 mL

12A.8.

25) The concentration of an unsaturated solution of a solid in a liquid may be markedly increased by

- A) a small decrease in temperature
- \*B) continuous evaporation of a substantial amount of the solvent
- C) an increase in pressure
- D) filtration

26) A mixture of 50 g of water and 50 g of common salt (solubility, 35 g/100 g of water) is well shaken. When stirring produces no more changes the total mass of the liquid phase in the container is

- A) 17.5 g
- B) 50 g
- \*C) 67.5 g
- D) 100 g

27) If a relatively small amount of solute is dissolved in a relatively large amount of solvent, the solution is said to be

- \*A) dilute
- B) an electrolyte
- C) supersaturated
- D) concentrated

28) What is the concentration of an HCl solution (hydrochloric acid), 30% HCl by mass and specific gravity 1.2?

- A) 0.82 mol/L
- B) 6.8 mol/L
- \*C) 9.9 mol/L
- D) 12.5 mol/L

12A.8.

29) The concentration of NaOH (sodium hydroxide) in a solution containing 1.00 g of NaOH in 200 mL of solution is

- A) 0.0500 mol/L
- B) 2.00 mol/L
- \*C) 0.125 mol/L
- D) 0.250 mol/L

30) A gas is most soluble in water at

- A) low pressure and low temperature
- B) high pressure and high temperature
- \*C) high pressure and low temperature
- D) low pressure and high temperature

31) The concentration of a solution that contains 2.275 mol of solute in a volume of 350 mL of solution is

- A) 0.00650 mol/L
- B) 0.150 mol/L
- C) 0.790 mol/L
- \*D) 6.50 mol/L

32) What is the percentage of solute by mass in a solution prepared by dissolving 50 g of  $\text{KNO}_3$  in 200 g of water?

- \*A) 20%
- B) 25%
- C) 50%
- D) 80%

12A.8.

33) A salt forms a saturated solution which contains 15.0% solute by mass. The solubility of this salt in g per 100 g of solvent is

- A) 11.3
- B) 12.8
- C) 15.0
- \*D) 17.6

34) The concentration of an  $\text{H}_2\text{SO}_4$  (sulfuric acid) solution that is prepared by dissolving 4.9 g of pure  $\text{H}_2\text{SO}_4$  in sufficient water to make 100 mL of solution is

- A) 0.05 mol/L
- B) 0.25 mol/L
- \*C) 0.50 mol/L
- D) 1.0 mol/L

35) 8.00 g of NaOH (sodium hydroxide) is dissolved in sufficient water to make 200 mL of solution. The concentration of the solution is

- \*A) 1.00 mol/L
- B) 0.200 mol/L
- C) 0.250 mol/L
- D) 0.500 mol/L

36) The number of moles of solute in 250 mL of a 4.0 mol/L solution is

- \*A) 1.0
- B) 2.0
- C) 0.063
- D) 4.0

12A.8.

- 37) The mass of solid lead(II) nitrate,  $\text{Pb}(\text{NO}_3)_2$ , required to prepare 125 mL of a 0.4 mol/L solution of lead(II) nitrate is
- A) 13.5 g
  - \*B) 16.6 g
  - C) 41.4 g
  - D) 331 g
- 38) 3.50 L of 0.200 mol/L  $\text{HCl}(\text{aq})$  (hydrochloric acid) is to be prepared using 12.0 mol/L  $\text{HCl}(\text{aq})$  stock solution. What volume of the 12.0 mol/L solution is required?
- A) 7.00 mL
  - B) 8.40 mL
  - C) 17.1 mL
  - \*D) 58.3 mL
- 39) The concentration of  $\text{KCl}(\text{aq})$  (potassium chloride) in a solution is 7.46 g per 100 mL of solution. The concentration of  $\text{KCl}$  in the solution can also be expressed as
- \*A) 1.00 mol/L
  - B) 10.0 mol/L
  - C) 14.9 mol/L
  - D) 74.6 mol/L
- 40) 196 g of pure  $\text{H}_2\text{SO}_4$  (sulphuric acid) is dissolved in enough water to make 500 mL of solution. The concentration of the solution, in  $\text{kmol/m}^3$ , is:
- A) 1.0
  - B) 2.0
  - C) 0.4
  - \*D) 4.0

12A.8.

41) What mass of KCl (potassium chloride) is present in 75.0 g of a solution which is 8%, by mass, KCl?

- \*A) 6.00 g
- B) 8.00 g
- C) 74.4 g
- D) 750 g

42) A solution contains 25.0 g of a solute, relative molecular mass 46.8, dissolved in 350 mL of solution. The concentration of the solute in the solution is

A)  $25.0 \times 46.8 \times 350 \text{ mol/L}$

\*B)  $\frac{25.0}{46.8 \times 0.350} \text{ mol/L}$

C)  $\frac{46.8 \times 25.0}{350} \text{ mol/L}$

D)  $\frac{0.350}{46.8 \times 25.0} \text{ mol/L}$

43) The volume of 0.300 mol/L  $\text{CH}_3\text{COOH}$  (acetic acid) solution that can be prepared from 100 mL of glacial acetic acid (17.4 mol/L) is

- A) 0.525 L
- B) 1.74 L
- C) 2.90 L
- \*D) 5.80 L

44) As liquid water is heated from room temperature ( $20^\circ\text{C}$ ) toward its boiling point, its density

- A) increases steadily
- \*B) decreases steadily
- C) remains unchanged
- D) increases and then decreases

12A.8.

45) Which statements are correct concerning the electrolysis of water?

- I Hydrogen collects at the cathode and oxygen at the anode.
- II The volumes of the gases produced are equal.
- III The gases can be distinguished by their behaviour toward burning or glowing splints.
- IV The gases can be distinguished by a difference in colour and odour.

- A) I and II
- \*B) I and III
- C) II and III
- D) II and IV

46) Efflorescence is the opposite of

- A) effervescence
- B) evaporation
- \*C) deliquescence
- D) precipitation

47) The chemical combination of a substance with water during crystallization is called

- A) condensation
- B) deliquescence
- \*C) hydration
- D) saturation

48) A hydrate which loses water on standing is said to be

- A) deliquescent
- \*B) efflorescent
- C) hygroscopic
- D) supersaturated

- 49) Calcium chloride is sometimes used on dirt roads to keep the dust down because calcium chloride is
- A) hydrated
  - B) allotropic
  - C) efflorescent
  - \*D) deliquescent
- 50) A substance which absorbs sufficient water from the air to form a solution is called
- \*A) deliquescent
  - B) homogeneous
  - C) efflorescent
  - D) heterogeneous
- 51) A true liquid solution is always
- \*A) transparent
  - B) opaque
  - C) coloured
  - D) colourless
- 52) A 10 g sample of sugar is dissolved in 150 g of water. The sugar and water are referred to, **RESPECTIVELY**, as the
- A) solvent and solute
  - B) solute and solution
  - \*C) solute and solvent
  - D) solution and solvent

12A.8.

53) A crystal of sodium chloride is dropped into a beaker containing a saturated solution of sodium chloride and some undissolved sodium chloride on the bottom of the beaker. What will be observed?

- A) The undissolved excess will dissolve.
- B) The added crystal will grow.
- \*C) No observable change will occur.
- D) The added crystal will dissolve.

54) All solutions are

- A) aqueous
- B) pure substances
- C) heterogeneous
- \*D) homogeneous

55) The "carbonation" in soft drinks is due to dissolved

- A)  $O_2$
- \*B)  $CO_2$
- C) CO
- D)  $H_2$

56) A solution in which the dissolved solute and the undissolved solute are in equilibrium is

- \*A) a saturated solution
- B) a strong solution
- C) an unsaturated solution
- D) a super-saturated solution

12A.8.

- 57) A solution that contains all the solute it can normally dissolve at a given temperature is
- A) strong
  - B) supersaturated
  - C) immiscible
  - \*D) saturated
- 58) Air is an example of
- \*A) a solution
  - B) an element
  - C) a compound
  - D) a pure substance
- 59) How many litres of 0.10 mol/L nitric acid ( $\text{HNO}_3$ ) solution, can be prepared from 63 g of pure  $\text{HNO}_3$ ?
- A) 1.0
  - B) 0.10
  - \*C) 10
  - D) 100
- 60) The mass of sodium hydroxide ( $\text{NaOH}$ ) that is present in 250 mL of a solution containing 2.0 mol of  $\text{NaOH}$  per litre of solution is
- A) 0.50 g
  - B) 10 g
  - \*C) 20 g
  - D) 80 g

12A.8.

61) 60 g of a 10%, by mass, solution of salt in water is mixed with 40 g of a 20%, by mass, solution of the same substance; the percentage composition, by mass, of the resulting solution is

- A) 8.0%
- \*B) 14%
- C) 15%
- D) 30%

62) A solution contains 65.0 g of a solute, molecular mass 43.9, dissolved in sufficient water to produce 1250 mL of solution. The concentration of the solution is

- A)  $\frac{65.0 \times 1250}{43.9} \text{ mol/L}$
- \*B)  $\frac{65.0}{43.9 \times 1.250} \text{ mol/L}$
- C)  $\frac{43.9 \times 65.0}{1250} \text{ mol/L}$
- D)  $\frac{65.0}{43.9 \times 1250} \text{ mol/L}$

63) Which of the following substances is least soluble in water at 25°C?

- A) sodium chloride
- \*B) silver chloride
- C) sodium hydroxide
- D) ammonium nitrate

12A.8.

- 64) 8.00 g of sodium hydroxide (NaOH) is dissolved in sufficient water to make 1.00 L of solution. What is the concentration of the solution expressed in moles of NaOH per litre of solution?
- A) 1.00
  - \*B) 0.200
  - C) 0.125
  - D) 8.00
- 65) If 9.8 g of sulfuric acid,  $\text{H}_2\text{SO}_4$ , is dissolved in sufficient water to form 1.0 L of solution, the concentration (mol/L) of the solution is
- A) 1.0 mol/L
  - B) 9.3 mol/L
  - \*C) 0.10 mol/L
  - D)  $9.8 \times 10^{-2}$  mol/L
- 66) What volume of hydrochloric acid (HCl) solution (12 mol/L) is required to prepare 3.0 L of 6.0 mol/L hydrochloric acid solution?
- A) 0.67 L
  - \*B) 1.5 L
  - C) 6.0 L
  - D) 6.7 L
- 67) 50.0 mL of 0.125 mol/L sulphuric acid,  $\text{H}_2\text{SO}_4$ , solution is diluted with water to 1.00 L. The concentration of hydrogen ion,  $\text{H}^+(\text{aq})$ , in the diluted solution is
- A) 0.00625 mol/L
  - \*B) 0.0125 mol/L
  - C) 0.125 mol/L
  - D) 0.250 mol/L

68) Solubility is defined as

- \*A) the maximum number of grams of solute that can dissolve in 100 g of solvent at a specific temperature
- B) the minimum number of grams of solute that can dissolve in 100 g of solvent to produce an unsaturated solution
- C) the maximum number of grams of solvent that can dissolve in 100 g of solute at a specific temperature
- D) the ability of a solute to dissolve in various solvents at a specified temperature

69) The density of water,  $\text{H}_2\text{O}$ , is greater than that of octane,  $\text{C}_8\text{H}_{18}$ , because

- A) there are no Van der Waals forces acting among octane molecules
- B) the molecular mass of water is smaller than that of octane
- C) water has a higher boiling point than octane
- \*D) intermolecular hydrogen bonding, present in water, is absent in octane

70) Which one of the following compounds might be expected to exhibit efflorescence?

- \*A)  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
- B)  $\text{Al}_2(\text{SO}_4)_3$
- C)  $\text{KAlSO}_4$
- D)  $(\text{NH}_4)_3\text{PO}_4$

12A.8.

71) The compound which is least soluble in water is

- \*A)  $\text{Ca}(\text{OH})_2$  (calcium hydroxide)
- B)  $\text{Pb}(\text{NO}_3)_2$  (lead(II) nitrate)
- C)  $\text{KNO}_3$  (potassium nitrate)
- D)  $\text{NaCl}$  (sodium chloride)

72) What volume of 2.00 mol/L acetic acid,  $\text{CH}_3\text{COOH}$ , solution can be made from 6.00 g of pure acetic acid?

- \*A)  $5.00 \times 10^{-2}$  L
- B)  $5.00 \times 10^{-1}$  L
- C) 5.00 L
- D) 20.0 L

73) Adding a crystal of solute to a saturated solution of the solute results in

- A) the formation of additional crystals
- \*B) no perceptible change in the crystal that was added
- C) dissolution of the added crystal
- D) the formation of a crystal hydrate

74) All solutions are

- A) liquids
- B) heterogeneous
- \*C) homogeneous
- D) pure substances

12A.8.

75) The water of hydration in a crystalline compound can be removed by

- A) filtration
- B) electrolysis
- \*C) heating
- D) settling

76) How many moles of water,  $\text{H}_2\text{O}$ , are there in 1000 g of  $\text{H}_2\text{O}$ ?

- A) 18.0
- B) 36.0
- \*C) 55.5
- D)  $1.00 \times 10^3$

77) How much 6 mol/L hydrochloric acid,  $\text{HCl}$ , would be needed to make 2 L of 0.3 mol/L  $\text{HCl}$  solution?

- \*A) 0.1 L
- B) 0.2 L
- C) 1 L
- D) 2 L

78) A sample of magnesium sulfate hydrate with a mass of 2.465 g contains 1.204 g of anhydrous magnesium sulfate,  $\text{MgSO}_4$ . The formula of the hydrated compound is

- A)  $\text{MgSO}_4 \cdot \text{H}_2\text{O}$
- B)  $\text{MgSO}_4 \cdot 2\text{H}_2\text{O}$
- C)  $\text{MgSO}_4 \cdot 3\text{H}_2\text{O}$
- \*D)  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$





12A.8.

79) 24.4 g of  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$  (barium chloride dihydrate) is heated to constant mass in a crucible. The approximate mass of the residue is

- A) 18.6 g
- B) 19.8 g
- \*C) 20.8 g
- D) 22.4 g

80) Which of the following methods could be used to separate the components of a solution?

- A) filtration
- B) settling and decanting
- C) centrifuging
- \*D) distillation

81) A substance which absorbs sufficient water from the atmosphere to form a solution is said to be

- A) efflorescent
- B) hydrophobic
- C) hygroscopic
- \*D) deliquescent

82) The volume of 0.100 mol/L  $\text{HCl(aq)}$  which must be diluted with water to produce 1.0 L of 0.010 mol/L  $\text{HCl}$  is

- \*A) 100 mL
- B) 200 mL
- C) 300 mL
- D) 400 mL

12A.8.

83) The number of moles of copper ion present in 200 mL of a 0.250 mol/L solution of  $\text{CuSO}_4$  (copper(II) sulfate) is

- \*A) 0.0500
- B) 1.10
- C) 3.20
- D) 12.5

84) The number of moles of KOH (potassium hydroxide) needed to prepare 2 L of a 2 mol/L solution of KOH is

- A) 1
- B) 2
- C) 3
- \*D) 4

85) Efflorescence is most likely to occur

- \*A) in a dry atmosphere
- B) in humid air
- C) under water
- D) in steam

86) An aqueous  $\text{Na}_3\text{AsO}_4$  (sodium arsenate) solution has a density of 1.24 g/mL at laboratory temperature and is 12.0% sodium arsenate by mass. The concentration of sodium arsenate in the solution is

- A) 103 g/L
- B) 120 g/L
- \*C) 149 g/L
- D) 185 g/L

12A.8.

87) The concentration of an aqueous KCl (potassium chloride) solution is 7.46 g per 100 mL of solution. The KCl concentration, in mol/L, is

- \*A) 1.00
- B) 10.0
- C) 14.9
- D) 74.6

88) Which one of the following terms best describes a salt which combines with a definite amount of water during crystallization?

- A) non-electrolyte
- B) electrolyte
- \*C) hydrate
- D) ion

89) 3.80 g of  $\text{C}_6\text{H}_4\text{Cl}_2$  (paradichlorobenzene) is dissolved in 15.60 g of  $\text{C}_6\text{H}_6$  (benzene). The percentage by mass of the  $\text{C}_6\text{H}_4\text{Cl}_2$  in the solution is

- A) 18.2%
- \*B) 19.6%
- C) 24.4%
- D) 80.4%

90) One gram of sodium chloride, NaCl, is dissolved in enough water to make 415 mL of solution. The concentration of NaCl in the solution is

- A)  $4.12 \times 10^{-5}$  mol/L
- B)  $7.09 \times 10^{-3}$  mol/L
- \*C)  $4.12 \times 10^{-2}$  mol/L
- D) 2.41 mol/L

12A.8.

91) Given the following formulae and relative molecular masses which of the compounds contains the highest percent by mass water of hydration?

Formula	Relative Molecular Mass
A) $\text{Cr}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$	716
B) $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	322
C) $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$	286
*D) $\text{LiNO}_3 \cdot 8\text{H}_2\text{O}$	209

92) The number of grams of sodium iodide, NaI, needed to make up one litre of 0.10 mol/L solution is

- A) 0.15
- B) 1.0
- C) 1.5
- \*D) 15

93) A solid which dissolves in a liquid to form a solution is called the

- A) dispersing medium
- B) precipitate
- \*C) solute
- D) solvent

94) What is the concentration (in mol/L) of a solution of sulfuric acid,  $\text{H}_2\text{SO}_4$ , that contains 15.0 g of pure  $\text{H}_2\text{SO}_4$  in 200 mL of solution?

- A) 0.31
- B) 0.59
- \*C) 0.77
- D) 0.95

12A.8.

95) What mass of potassium chloride,  $\text{KCl}$ , is required to make 2.0 L of a 0.050 mol/L solution?

- A) 1.9 g
- B) 3.8 g
- \*C) 7.5 g
- D) 15 g

96) Water is given off when a dry crystalline material is heated. The crystalline material was

- A) anhydrous
- \*B) hydrated
- C) deliquescent
- D) effervescent

97) Calcium chloride,  $\text{CaCl}_2$ , is sometimes used on dirt roads to keep the dust down because the calcium chloride is

- A) efflorescent
- \*B) deliquescent
- C) anhydrous
- D) hydrated

98) 8.70 g of naphthalene,  $\text{C}_{10}\text{H}_8$ , is dissolved in 26.3 g of benzene,  $\text{C}_6\text{H}_6$ . The percentage by mass of naphthalene in the solution is

- A) 23.7%
- B) 24.1%
- \*C) 24.9%
- D) 23.1%

12A.8.

99) A 7.50 g sample of nickel(II) sulfate,  $\text{NiSO}_4$ , is dissolved in 250 mL of water. The concentration of the resulting solution in grams of  $\text{NiSO}_4$  per 100 mL of water is

- A) 3.33
- B) 3.20
- \*C) 3.00
- D) 18.75

100) A 12.500 g sample of hydrated sodium acetate,  $\text{NaC}_2\text{H}_3\text{O}_2 \cdot x\text{H}_2\text{O}$ , is heated to dryness and then allowed to cool; 7.530 g of the anhydrous salt remains. What is the number of water molecules represented in the formula of the hydrate?

- A) 5
- B) 2
- \*C) 3
- D) 4

101) A solution contains 65.0 g of solute, whose relative molecular mass 43.9, dissolved in  $1.25 \times 10^3$  mL of the solution. The concentration of the solution, in mol/L, is

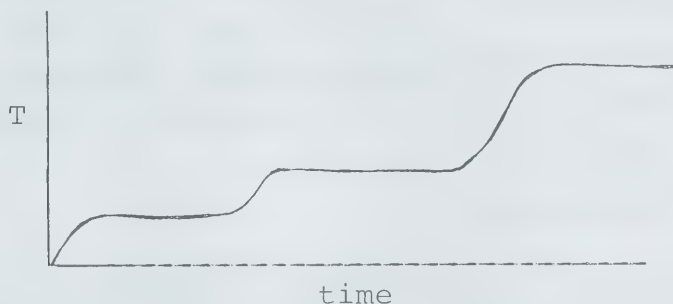
- A)  $\frac{65.0}{43.9} \times \frac{1}{1250}$
- \*B)  $\frac{65.0}{43.9 \times 1.25}$
- C)  $\frac{43.9 \times 65.0}{1250}$
- D)  $65.0 \times 43.9 \times 1250$

12A.8.

102) What mass of solvent must be added to 80 g of solute in order to obtain a solution which is 20% solute by mass?

- A) 16 g
- \*B) 320 g
- C) 400 g
- D) 480 g

103) The following graph is a plot of data obtained from the distillation of a solution. The number of components in the initial solution was



- A) 1
- B) 2
- \*C) 3
- D) 4

104) A solution of sodium chloride,  $\text{NaCl}$ , is in contact with an undissolved excess of the salt. If an additional crystal of sodium chloride is dropped into the solution

- A) the undissolved excess will dissolve
- B) more precipitate will form
- C) the additional crystal will dissolve
- \*D) no observable changes will take place

12A.8.

105) 1.0 L of a 0.5 mol/L solution of sodium sulfide,  $\text{Na}_2\text{S}$ , contains

- A) 0.5 L of water
- \*B) 1.0 mol of  $\text{Na}^+(\text{aq})$  and 0.5 mol of  $\text{S}^{2-}(\text{aq})$
- C) 1.0 mol of all solute particles
- D) 0.5 mol of  $\text{Na}^+(\text{aq})$  and 0.5 mol of  $\text{S}^{2-}(\text{aq})$

106) 2.191 g of a hydrate of calcium chloride produces 1.110 g of the anhydrous salt,  $\text{CaCl}_2$ . The formula of the hydrate is

- A)  $\text{CaCl}_2 \cdot 3\text{H}_2\text{O}$
- B)  $\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$
- C)  $\text{CaCl}_2 \cdot 5\text{H}_2\text{O}$
- \*D)  $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$

107) The number of grams of sodium chloride,  $\text{NaCl}$ , in 1.00 L of a 2.00 mol/L solution of this salt is

- A) 58.5
- B) 81.5
- C) 94.0
- \*D) 117

108) The process by which a crystal loses water on standing is called

- A) deliquescence
- \*B) efflorescence
- C) decrepitation
- D) hydration

12A.8.

109) What volume of 6.0 mol/L hydrochloric acid, HCl, is needed to prepare 300 mL of 0.030 mol/L solution?

- \*A) 1.5 mL
- B) 15 mL
- C) 3.0 mL
- D) 30 mL

110) Gas collection by water displacement is used for gases which are

- A) coloured
- B) more dense than air
- \*C) not appreciably water soluble
- D) more dense than water

111) 250 mL of a 0.6 mol/L solution of iron(II) sulfate,  $\text{FeSO}_4$ , is prepared. The number of grams of  $\text{FeSO}_4$  used is

- A) 0.15
- B) 15.6
- \*C) 22.8
- D) 63.3

112) What is the number of grams of calcium oxide, CaO, in 1 L of a 1.0 mol/L solution of this substance?

- A) 24
- B) 37
- \*C) 56
- D) 84

12A.8.

113) The solubility of sodium chloride, NaCl, is about 35 g per 100 mL of water at 288 K. If 1.0 g of NaCl is added to 1.0 L of water, the resulting solution is

- A) saturated and concentrated
- \*B) unsaturated and dilute
- C) unsaturated and concentrated
- D) saturated and dilute

114) A solution of sodium hydroxide, NaOH, has a density of 1.1 g/mL and contains 30% solute by mass. The mass of the solute present in 75 mL of this solution is

- A) 23 g
- \*B) 25 g
- C) 28 g
- D) 33 g

115) Bluestone,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , is an example of a(n)

- \*A) hydrate
- B) solid solution
- C) hydride
- D) anhydrous solution

116) The concentration of a solution containing 0.98 g of sulfuric acid,  $\text{H}_2\text{SO}_4$ , in 2.0 L of solution is

- \*A) 0.0050 mol/L
- B) 0.50 mol/L
- C) 5.0 mol/L
- D) 0.98 mol/L

12A.8.

117) 500 mL of a solution contains 0.20 mol of a salt. The concentration of salt in the solution is

- A) 0.010 mol/L
- B) 0.25 mol/L
- \*C) 0.40 mol/L
- D) 4.0 mol/L

118) Compounds which become wet and dissolve upon exposure to air are said to be

- \*A) deliquescent
- B) efflorescent
- C) hygroscopic
- D) anhydrous

119) When 24.54 g of lanthanum chloride,  $\text{LaCl}_3$ , is dissolved in enough water to make 1000 mL of solution, the concentration of lanthanum and chloride ions are respectively

(The relative atomic masses of La and Cl are 138.9 and 35.5)

- A)  $\text{La}^{3+}(\text{aq}) = 0.025 \text{ mol/L}$ ;  $\text{Cl}^{-}(\text{aq}) = 0.075 \text{ mol/L}$
- B)  $\text{La}^{3+}(\text{aq}) = 0.10 \text{ mol/L}$ ;  $\text{Cl}^{-}(\text{aq}) = 0.10 \text{ mol/L}$
- \*C)  $\text{La}^{3+}(\text{aq}) = 0.10 \text{ mol/L}$ ;  $\text{Cl}^{-}(\text{aq}) = 0.30 \text{ mol/L}$
- D)  $\text{La}^{3+}(\text{aq}) = 0.30 \text{ mol/L}$ ;  $\text{Cl}^{-}(\text{aq}) = 0.10 \text{ mol/L}$

120) The mass of hydrogen chloride,  $\text{HCl}$ , present in 200 mL of 0.500 mol/L  $\text{HCl}$  is

- A) 0.10 g
- \*B) 3.65 g
- C) 7.30 g
- D) 36.5 g

12A.8.

121) The number of moles of hydrogen chloride,  $\text{HCl}$ , present in 30 mL of 3.0 mol/L  $\text{HCl}$  is

- A) 0.0090 mol
- \*B) 0.090 mol
- C) 0.90 mol
- D) 9.0 mol

123) If much more solute can be dissolved in a solution without altering the temperature the solution is said to be

- A) saturated
- B) supersaturated
- \*C) unsaturated
- D) concentrated

123) Sodium thiosulfate pentahydrate changes from transparent crystals to white particles on exposure to the air. If this change is accompanied by a loss of mass, the original compound is apparently

- \*A) efflorescent
- B) anhydrous
- C) deliquescent
- D) effervescent

124) To make 500 mL of a 1.60 mol/L solution of potassium chloride,  $\text{KCl}$ , the mass of  $\text{KCl}$  required is

- A) 74.6 g
- B) 239 g
- C) 1.60 g
- \*D) 59.7 g

12A.8.

125) At 303 K, 9.00 g of potassium chloride,  $\text{KCl(s)}$ , will exactly saturate 25.0 mL of water. The solubility of  $\text{KCl}$  in grams per litre of water, at 303 K, is

- A) 109
- B) 186
- C) 255
- \*D) 360

126) Which of the following statements are correct?

- I) Any solid can dissolve readily in any liquid.
- II) When solute A dissolves in solvent B, the interionic or intermolecular forces of both A and B have to be overcome.
- III) All solid solutes break down into molecules when in solution.
- IV) Some solids break down into molecules while others furnish ions when they dissolve.

- A) I and II
- B) II and III
- \*C) II and IV
- D) I and III

127) A solution of calcium nitrate,  $\text{Ca(NO}_3)_2$ , is 4.0% solute by mass. The amount of calcium nitrate that is present in 85 g of solution is

- A) 2.1 g
- B) 2.8 g
- \*C) 3.4 g
- D) 3.9 g

12A.8.

128) 1 L of a 1.0 mol/L solution of sodium chloride,  $\text{NaCl(aq)}$ , solution contains

- A) 0.5 mol of  $\text{Na}^+$  ions and 0.5 mol of  $\text{Cl}^-$  ions
- \*B) one mole of  $\text{Na}^+$  ions and one mole of  $\text{Cl}^-$  ions
- C) one mole of  $\text{NaCl}$  molecules
- D) three moles of molecules

129) If sodium hydroxide,  $\text{NaOH}$ , is left in the open air for a while, it becomes quite moist, and eventually forms a solution. Such a substance is called

- A) efflorescent
- B) hydrated
- \*C) deliquescent
- D) effervescent

130) 4.0 g of sodium hydroxide,  $\text{NaOH}$ , is dissolved in 500 mL of solution. The concentration of  $\text{NaOH}$  in the solution is

- A) 0.0040 mol/L
- B) 0.050 mol/L
- C) 0.10 mol/L
- \*D) 0.20 mol/L

131) Sugar will dissolve in water most rapidly if the sugar is

- \*A) powdered
- B) lump
- C) granulated
- D) rock candy

12A.8.

- 132) Water is added to 100 mL of 2.0 mol/L sulphuric acid,  $\text{H}_2\text{SO}_4$ , until the total volume is 500 mL. The concentration of sulphuric acid in the resulting solution is
- A) 0.10 mol/L
  - B) 0.20 mol/L
  - \*C) 0.40 mol/L
  - D) 1.0 mol/L
- 133) A solution is made up of 100 g of sugar and 150 g of water. The percentage composition, by mass, of sugar in the solution is
- A) 33.3%
  - \*B) 40.0%
  - C) 60.0%
  - D) 66.7%
- 134) Aluminum chloride forms a hydrate with the formula  $\text{Al}_2\text{Cl}_6 \cdot n\text{H}_2\text{O}$ . The substance was analysed to determine the percentage water in the hydrate. In the analysis the crucible and the sample of aluminum chloride were heated "to constant mass".

Data:	Mass of crucible	22.54 g
	Mass of crucible and hydrate	31.44 g
	Mass of crucible and residue after heating	27.84 g

The percentage of water in the hydrate is

- A) 36.0%
- \*B) 40.4%
- C) 59.6%
- D) 67.9%

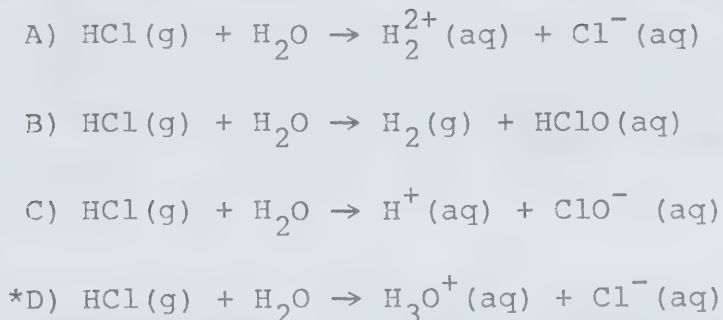
12A.8.

135) In 350 mL of a 6.5 mol/L solution there are

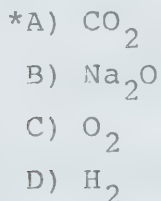
- A) 0.019 mol of solute
- B) 0.054 mol of solute
- \*C) 2.3 mol of solute
- D) 54 mol of solute

12A.9.

- 1) The reaction between gaseous hydrogen chloride and water is best represented by



- 2) Which of the following will form an acidic solution when dissolved in water?



- 3) Both copper metal and sodium chloride have high melting points. Copper conducts electricity well as a solid, while sodium chloride conducts electricity only when melted or dissolved in a polar solvent. The difference in electrical conductivity is best explained by the

- A) stronger bonding forces between particles in NaCl than in Cu
- \*B) greater mobility of electrons in solid Cu than in solid NaCl
- C) greater number of atoms in a mole of Cu than in a mole of NaCl
- D) fewer kinds of atoms in Cu than in NaCl

12A.9.

4) Which of the following substances is a non-electrolyte when dissolved in water?

- \*A) sugar
- B) sulphuric acid
- C) sodium hydroxide
- D) sodium chloride

5) Which of the following substances, when dissolved in water, is a NON-electrolyte?

- A) ammonia
- \*B) sugar
- C) sodium chloride
- D) sodium hydroxide

6) Which of the following substances, when dissolved in water, is a NON-electrolyte?

- A) NaCl
- B)  $\text{HNO}_3$
- \*C)  $\text{CH}_3\text{OH}$
- D)  $\text{Cu}(\text{NO}_3)_2$

7) Which of the following compounds would be most highly dissociated in water at room temperature and pressure?

- A) ammonia ( $\text{NH}_3$ )
- B) acetic acid ( $\text{CH}_3\text{COOH}$ )
- \*C) hydrochloric acid ( $\text{HCl}$ )
- D) methyl alcohol ( $\text{CH}_3\text{OH}$ )

12A.9.

- 8) When one molecule of hydrogen phosphate ( $\text{H}_3\text{PO}_4$ ) ionizes (in water) the maximum number of ions formed is
- A) 1
  - B) 8
  - C) 3
  - \*D) 4
- 9) The ions formed when magnesium bromide dissolves in water are
- \*A)  $\text{Mg}^{2+}$ ,  $2\text{Br}^-$
  - B)  $\text{Mg}^{2+}$ ,  $\text{Br}^{2-}$
  - C)  $\text{Mg}_2^+$ ,  $\text{Br}^{2-}$
  - D)  $\text{Mg}^+$ ,  $\text{Br}^-$
- 10) In electrolysis reactions which one of the following statements is TRUE?
- \*A) oxidation takes place at the anode
  - B) reduction takes place at the anode
  - C) metal ions form metals at the anode
  - D) all gases are formed at the cathode

12A.9.

11) Hydrogen combines with oxygen to form hydrogen oxide (water). In this reaction

- A) hydrogen and oxygen are oxidized
- B) hydrogen and oxygen are reduced
- C) hydrogen is reduced and oxygen is oxidized
- \*D) hydrogen is oxidized and oxygen is reduced

12) When an element accepts electrons, it

- \*A) is reduced
- B) is oxidized
- C) becomes electropositive
- D) behaves as a metal

13) During electrolysis, the chemical reaction taking place at the cathode is called

- A) activation
- \*B) reduction
- C) oxidation
- D) neutralization

14) Which of the following equations represents the oxidation of the iron(II) ion?

- A)  $\text{Fe}^{3+} + \text{e}^{-} \rightarrow \text{Fe}^{2+}$
- B)  $\text{Fe}^{2+} + 2\text{e}^{-} \rightarrow \text{Fe}$
- C)  $\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^{-}$
- \*D)  $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^{-}$

12A.9.

15) Chlorine is termed a stronger oxidizing agent than bromine because chlorine

- A) has a higher atomic mass than bromine
- \*B) has a higher electronegativity than bromine
- C) has fewer valence electrons than bromine
- D) is more metallic than bromine

16) The valence of carbon in  $\text{CO}_2$  is

- A) 0
- B) 1
- C) 2
- \*D) 4

17) A solution which contains an equal number of hydrogen ions and hydroxide ions is

- A) an acidic solution
- B) a basic solution
- \*C) a neutral solution
- D) a solid solution

18) Some aqueous solutions are strongly basic because

- A) they contain a high concentration of metallic ions
- B) they contain a high concentration of hydronium ions
- C) they hardly dissociate into their constituent ions
- \*D) they contain a high concentration of hydroxide ions

19) An acidic solution, such as vinegar,

- A) turns litmus paper blue
- B) has a salty taste
- \*C) has a sour taste
- D) feels slippery

12A.9.

- 20) The species responsible for the acidic properties of any aqueous acid is
- A) the hydroxide ion
  - \*B) the hydrogen ion
  - C) the negative ion
  - D) the oxide ion
- 21) Dilute bases have all EXCEPT one of the following properties in common. Identify the EXCEPTION
- A) they feel slippery
  - \*B) they turn bromothymol blue yellow
  - C) they neutralize acids
  - D) they turn litmus paper blue
- 22) The products formed when potassium hydroxide reacts with sulphuric acid are
- A) a salt and hydrogen
  - B) sulphur dioxide and water
  - C) a metallic oxide and water
  - \*D) a salt and water
- 23) When neutral bromthymol blue indicator is added to a dilute hydrochloric acid solution the colour of the resulting solution is
- \*A) yellow
  - B) green
  - C) blue
  - D) colourless

12A.9.

24) The products of any neutralization reaction are

- A) carbon dioxide and water
- B) an acid and a base
- \*C) a salt and water
- D) sodium chloride and water

25) In the neutralization reaction between strontium hydroxide ( $\text{Sr}(\text{OH})_2$ ) and perchloric acid ( $\text{HClO}_4$ ) the products are water and

- \*A)  $\text{Sr}(\text{ClO}_4)_2(\text{aq})$
- B)  $\text{Sr}_2\text{Cl}_2(\text{aq})$
- C)  $\text{Sr}_2\text{ClO}_4(\text{aq})$
- D)  $\text{SrClO}_3(\text{aq})$

26) Potassium chlorate is a salt of

- A) chlorous acid
- B) hydrochloric acid
- \*C) chloric acid
- D) hypochlorous acid

27) Bromthymol blue indicator is yellow in an aqueous solution of

- \*A) sulfur dioxide
- B) sodium oxide
- C) magnesium oxide
- D) sulphur

28) The equation:



represents

- \*A) a neutralization reaction
- B) an oxidation-reduction reaction
- C) a combustion reaction
- D) a decomposition reaction

29) Clean pieces of copper wire are placed in each of the aqueous solutions listed below. In which case will a reaction be first observed?

- A) sodium chloride
- B) ammonium hydroxide
- \*C) chlorine
- D) calcium iodide

30) A strip of metal was immersed in a solution of aluminum sulphate and no apparent reaction was observed. It was then immersed in a solution of tin(II) nitrate and became coated with tin. The metal is

- A) less active than tin but more active than aluminum
- B) a weaker reducing agent than tin only
- C) a stronger reducing agent than aluminum only
- \*D) less active than aluminum but more active than tin

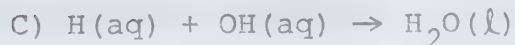
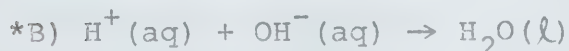
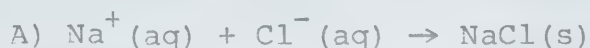
12A.9.

- 31) The reaction of aqueous solutions of sodium chloride, NaCl, and silver nitrate, AgNO<sub>3</sub>, is represented by the equation:



The reaction proceeds nearly to completion because

- A) the sodium and nitrate ions do not react
  - B) the reactants are water soluble
  - \*C) an insoluble product is formed
  - D) the reaction is reversible
- 32) The net ionic equation for the reaction between NaOH(aq) (sodium hydroxide) and dilute HCl (hydrochloric acid) is



12A.9.

33) The following table gives information about the properties of some pure substances.

<u>Pure Substance</u>	<u>Electrical Conductivity</u>			<u>Melting Point</u>	
	Solid	Liquid	Solution in Water	(K)	(°C)
1	Poor	Good	Good	1074	801
2	Good	Good	Not soluble	1723	1450
3	Good	Good	Not soluble	1813	1540
4	Poor	Poor	Good	162	-101
5	Poor	Good	Good	1043	770
6	Poor	Poor	Good	392	119
7	Poor	Poor	Not soluble	1683	1410

The pure substances which change from a molecular structure to ions when dissolved in water are

- A) 1 and 2
- B) 3 and 4
- \*C) 4 and 6
- D) 5 and 6

34) The following table sets out information about some common substances.

	Melting Point	Electrical Conductivity of solid	Electrical Conductivity of liquid	Electrical conductivity of solution in water
1) xylene ( $C_6H_4(CH_3)_2$ )	-25°C	poor	poor	insoluble
2) hydrogen iodide (HI)	-51°C	poor	poor	good
3) potassium bromide (KBr)	730°C	poor	good	good
4) magnesium chloride ( $MgCl_2$ )	712°C	poor	good	good

The substance which forms ions when dissolved in water is

- A) 1
- \*B) 2
- C) 3
- D) 4

12A.9.

- 35) When  $\text{H}_2$  (hydrogen) is produced in an open container by the action of sulphuric acid ( $\text{H}_2\text{SO}_4$ ) on zinc (Zn) according to the equation:

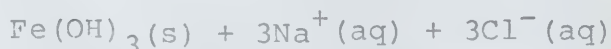
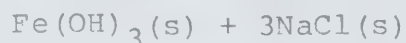


the reaction goes to completion because

- A) a chemical equilibrium is soon reached
  - B) an insoluble solid is formed
  - \*C) a gas is formed and escapes from the reaction vessel
  - D) the acid used has a high boiling point
- 36) Three moles of sodium hydroxide,  $\text{NaOH}$ , are added to one mole of phosphoric acid,  $\text{H}_3\text{PO}_4$ . The resulting salt is sodium
- \*A) phosphate
  - B) monohydrogen phosphate
  - C) dihydrogen phosphate
  - D) trihydrogen phosphate
- 37) A solution of  $0.01 \text{ mol/L}$   $\text{HCl}$  (hydrochloric acid) is prepared. On the assumption that the  $\text{HCl}$  is 100% ionized at this concentration, the concentration of  $\text{OH}^-$  in this solution is
- A)  $1.0 \times 10^{-2} \text{ mol/L}$
  - B)  $1.0 \times 10^{-4} \text{ mol/L}$
  - C)  $1.0 \times 10^{-10} \text{ mol/L}$
  - \*D)  $1.0 \times 10^{-12} \text{ mol/L}$

12A.9.

- 38) In an experiment it was found that mixing equal volumes of solutions of  $\text{FeCl}_3$  (0.1 mol/L) and  $\text{NaOH}$  (0.1 mol/L) produced a precipitate of  $\text{Fe}(\text{OH})_3$ . Which of the following equations best represents the net ionic equation for the reaction?



- 39) What mass of  $\text{H}_2\text{O}$  (water) is produced by the reaction of 16 g of  $\text{CH}_3\text{OH}$  (methanol), according to the following equation?



A) 9.0 g

\*B) 18 g

C) 36 g

D) 72 g

- 40) A reaction vessel was filled with 8 g of  $\text{H}_2(\text{g})$  (hydrogen gas) and 32 g of  $\text{O}_2$  (oxygen gas); the mixture was exploded. Which one of the following statements is true?

A) After the reaction, the vessel would contain 6 g of hydrogen gas.

B) The reaction consumed heat energy.

C) 18 g of water would be produced.

\*D) All of the oxygen gas would be used up in the reaction.

12A.10.

1) The compound formed when calcium is allowed to react with a large excess of water is

- A)  $\text{CaO}$
- B)  $\text{CaOH}$
- \*C)  $\text{Ca(OH)}_2$
- D)  $\text{CaOH}_2$

2) Which of the following would most likely be found in bathtub ring?

- A) sodium stearate
- \*B) magnesium stearate
- C) potassium stearate
- D) sodium chloride

12A.11.

1) Which of the following electron configurations best represents one of the halogens?

\*A) 2, 8, 7

B) 2, 8, 2

C) 2, 8, 1

D) 2, 8

12A.12.

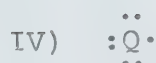
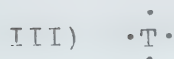
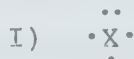
1) A certain element combines with hydrogen in a one to one atomic ratio, is a solid at room temperature, reacts vigorously with water and has the smallest atomic radius in its family in the Periodic Table. The element is

- A) F
- B) Fr
- \*C) Li
- D) P

2) The original format of the Periodic Table, as described by Mendeleev, was based on the arrangement of the elements

- \*A) according to chemical properties
- B) in order of increasing density
- C) in order of increasing number of neutrons
- D) with reference to nuclear stability

3) Which of the following elements from row 3 of the Periodic Table, in solid form, would be the best conductor of heat and electricity?



- A) I
- \*B) II
- C) III
- D) IV

12A.12.

4) The set of elements containing only non-metals is

- A) C, Cl, Li
- \*B) Cl, F, I
- C) Al, Ba, K
- D) Br, Fe, Ne

5) The element in the list below that reacts most vigorously with oxygen, at room temperature, is

- A) Barium (Ba)
- \*B) Cesium (Cs)
- C) Lithium (Li)
- D) Magnesium (Mg)

6) Atom X has 11 protons and 12 neutrons in its nucleus while atom Y has 12 protons and 12 neutrons in its nucleus. The elements X and Y are

- A) isotopes of the same element
- \*B) both metallic in character
- C) both non-metallic in character
- D) members of the same family in the Periodic Table

7) Which of the following metals exists as a liquid at room temperature and pressure?

- A) aluminum
- B) magnesium
- \*C) mercury
- D) tin

12A.12.

- 8) According to the Periodic Table the elements are arranged in order of increasing
- A) atomic mass
  - B) mass number
  - C) electron affinity
  - \*D) atomic number
- 9) The Periodic Table led Mendeleev to predict the existence of an element which he referred to as eka-silicon. This element is now known as
- A) sodium
  - B) gallium
  - \*C) germanium
  - D) neptunium
- 10) As the atomic numbers of the elements in a family of the Periodic Table increase, the
- A) atomic radii decrease
  - B) atomic masses decrease
  - \*C) ionization energies decrease
  - D) metallic characteristics decrease
- 11) The most electronegative element in the following list is
- A) chlorine
  - \*B) fluorine
  - C) oxygen
  - D) sulfur

12A.12.

- 12) The Periodic Table, based on an octet pattern, lead Mendeleev to predict the existance of an element which he referred to as eka-silicon. This element is now known as
- A) sodium
  - B) gallium
  - \*C) germanium
  - D) neptunium
- 13) In its present form, the Periodic Law states that the chemical properties of elements are periodic functions of their
- A) atomic mass
  - B) density
  - \*C) atomic number
  - D) isotopic weight
- 14) The reason for resemblance among elements of a given family in the Periodic Table is the
- \*A) similarity in the valence shell of the atoms
  - B) similarity in their nuclear structure
  - C) fact that they all have the same number of protons
  - D) fact that they all have the same number of neutrons
- 15) Chemists believe that the chemical properties and chemical activity of an element are related directly to the
- A) neutrons in the nucleus of an atom
  - B) atomic mass of the atom
  - \*C) valence electrons of the atom
  - D) difference between mass number and atomic number

12A.12.

16) The element in the fifth period of the Periodic Table having electrons in the configuration  $5p_x^2 5p_y^1 5p_z^1$  is

- \*A) Te
- B) Po
- C) Sb
- D) Bi

17) The electron configuration in the following set that represents the most reactive non-metal is

- A) 2, 8, 1
- B) 2, 8, 3
- \*C) 2, 8, 7
- D) 2, 8, 8

18) On the Periodic Table, elements in the same vertical column have atoms with the same

- \*A) outer electronic configuration
- B) principal quantum number for their outermost electrons
- C) attraction between the nucleus and the outer electrons
- D) ionization energy

19) The neutral atom of an element which contains eight electrons in its outer shell

- A) is chemically active
- \*B) is chemically inert
- C) has a charge of one
- D) loses one electron when reacting chemically

12A.12.

- 20) Values of 1st, 2nd and 3rd ionization energies of an unknown element are found to be as follows:

$$E_1 = 9.32 \text{ kJ/mol} \quad E_2 = 258 \text{ kJ/mol} \quad E_3 = 268 \text{ kJ/mol}$$

In which group of the Periodic table do you expect to find this element?

- \*A) I
- B) II
- C) VI
- D) IV

- 21) The electron configuration that represents the least reactive element is

- A) 2, 8, 1
- B) 2, 8, 3
- C) 2, 8, 7
- \*D) 2, 8, 8

- 22) An element that is a member of the noble gases is

- A) vanadium
- B) selenium
- C) astatine
- \*D) radon

- 23) The set of elements, all of which are members of the same group in the Periodic Table, is

- A) calcium, iron, magnesium
- B) oxygen, nitrogen, sulfur
- \*C) lithium, potassium, sodium
- D) carbon, manganese, silicon

12A.12.

24) The group of elements which is characterized by being low-density, soft metals and forming oxides with the general formula  $M_2O$  is the

- A) group VI elements
- B) halogen elements
- \*C) alkali metal elements
- D) alkaline earth elements

25) An element has ionization energies as follows:

1st ionization energy =  $7.35 \times 10^2$  kJ/mol

2nd ionization energy =  $1.45 \times 10^3$  kJ/mol

3rd ionization energy =  $7.72 \times 10^3$  kJ/mol

This element is a member of which one of the following groups?

- A) alkali metals (group I)
- \*B) alkaline earth metals (group II)
- C) noble gases (group VIII)
- D) halogens (group VII)

26) The elements in the Periodic Table which form very few compounds because their electronic configurations are very stable are all members of group

- A) I
- B) IV
- C) VII
- \*D) VIII

12A.12.

- 27) A family of elements represented by the letter X all exhibit the following characteristic reaction:



The name of this family is the

- A) alkali metals
  - B) alkaline earth metals
  - C) noble gases
  - \*D) halogens
- 28) Zn is a member of the Periodic Table family number
- A) I
  - \*B) II
  - C) III
  - D) IV
- 29) The Periodic Law states that the chemical properties of elements are periodic functions of their
- A) atomic masses
  - B) number of neutrons
  - \*C) atomic numbers
  - D) isotopic masses
- 30) In which group of the Periodic Table are the elements which usually combine with 2 atoms of potassium?
- A) I
  - B) II
  - \*C) VI
  - D) IV

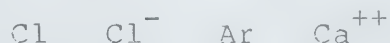
31) In the families of the Periodic Table metallic characteristics decrease from

- A) right to left and bottom to top
- B) right to left and top to bottom
- \*C) left to right and bottom to top
- D) left to right and top to bottom

32) Atom X has 11 protons and 12 neutrons in its nucleus. Atom Y has 12 protons and 11 neutrons in its nucleus. The elements X and Y

- A) are isotopes of the same element
- \*B) are both metallic elements
- C) belong to the same group in the Periodic Table
- D) belong to different periods in the Periodic Table

33) Given the following atoms and ions:



The particles in order of increasing radius are

- \*A)  $\text{Ca}^{++}$     Ar    Cl     $\text{Cl}^-$
- B)  $\text{Cl}^-$     Ar     $\text{Ca}^{++}$     Cl
- C) Ar     $\text{Ca}^{++}$      $\text{Cl}^-$     Cl
- D) Cl     $\text{Cl}^-$     Ar     $\text{Ca}^{++}$

34) Which of the following would react in a manner most similar to nitrogen?

- \*A) phosphorus (P)
- B) sodium (Na)
- C) neon (N)
- D) oxygen (O)

12A.12.

35) Consider the following properties of an element:

- I It is a liquid at  $-200^{\circ}\text{C}$
- II It forms an ion with a  $2^{-}$  charge
- III As a gas, the element is diatomic
- IV It is a gas at  $0^{\circ}\text{C}$

The element described is

- \*A) oxygen
- B) carbon
- C) chlorine
- D) nitrogen

36) The alkali metals (Li, Na, K) are similar in that they

- A) are very unreactive
- B) all form ions with a charge of  $2^{+}$
- \*C) all have one more electron than inert gases
- D) only react with each other

37) Which of the following properties decreases across a row from left to right in the Periodic Table?

- A) ionization energy
- B) atomic mass
- C) electron population
- \*D) atomic size

12A.12.

- 38) Successive ionization energies in kJ/mol for an unknown element are given below.

$$E_1 = 711 \quad E_2 = 1421 \quad E_3 = 7733 \quad E_4 = 9196$$

To which family of the Periodic Table does the element belong?

- A) I
  - \*B) II
  - C) III
  - D) IV
- 39) What determines the order of elements in the Periodic Table?
- A) size of elements
  - B) size of ions
  - C) number of neutrons
  - \*D) number of protons
- 40) Which of the following is the most reactive element?
- \*A) fluorine
  - B) helium
  - C) neon
  - D) krypton
- 41) Which of the following elements has the LOWEST first ionization energy?
- A) fluorine
  - B) neon
  - \*C) sodium
  - D) magnesium

12A.12.

- 42) In the periodic table elements with similar properties are grouped in
- A) horizontal rows
  - \*B) vertical columns
  - C) periods
  - D) diagonal rows
- 43) The elements are arranged in the periodic table in order of increasing
- A) ionization energy
  - B) mass number
  - C) electronegativity
  - \*D) atomic number
- 44) The most reactive of the following four elements is
- \*A) fluorine
  - B) bromine
  - C) iodine
  - D) astatine
- 45) The modern version of the periodic table lists the elements in the exact order of their
- \*A) atomic numbers
  - B) relative atomic masses
  - C) numbers of neutrons
  - D) mass numbers





12A.12.

- 46) Elements whose neutral atoms have the greatest ability to attract electrons are located
- A) in the upper left corner of the periodic table
  - \*B) in the upper right corner of the periodic table
  - C) in the lower left corner of the periodic table
  - D) in the lower right corner of the periodic table
- 47) Similar chemical properties are a result of
- A) similar nuclear charge
  - \*B) similar numbers of valence electrons
  - C) similar numbers of electron shells
  - D) similar physical properties
- 48) Two elements "A" and "Z" are members of the same family of elements. It can therefore be concluded that they have the same
- A) atomic radius
  - B) electronegativity
  - \*C) number of valence electrons
  - D) affinity for electrons
- 49) The element with atomic number 17 is a member of the family of
- A) inert gases
  - B) alkali metals
  - \*C) halogens
  - D) alkaline earth metals

12A.12.

50) The correct relationship between the electronegativities of the following pairs of elements is

- A) potassium greater than aluminum
- B) lithium greater than nitrogen
- C) sulfur less than selenium
- \*D) sulfur less than oxygen

51) Of the following groups of three elements, the elements whose properties are most nearly alike are those having atomic numbers

- A) 1, 2 and 3
- B) 1, 3 and 11
- C) 5, 6 and 7
- \*D) 13, 31 and 49

52) The element that has the strongest attraction for electrons is

- A) hydrogen
- B) sulfur
- C) calcium
- \*D) fluorine

53) Which one of the following arrangements of elements is in order of increasing atomic radius?

- A) Na    H    S    Al
- \*B) H    S    Al    Na
- C) H    Na    Al    S
- D) Al    S    H    Na

54) The number of elements known today is closest to

- A) 50
- B) 75
- \*C) 100
- D) 125

55) In any period of the Periodic Table where these symbols apply, the maximum number of electrons in the s, p, d and f sublevels are respectively

- A) 2    4    6    8
- B) 2    6    18    32
- C) 2    6    8    18
- \*D) 2    6    10    14

56) Across a row of the Periodic Table metallic character in general

- \*A) decreases from left to right
- B) increases from left to right
- C) increases from family I to family IV
- D) increases from family IV to family VII

57) An element with atomic number 11 is likely to have similar chemical properties to the element whose atomic number is

- A) 7
- B) 2
- C) 9
- \*D) 19

12A.12.

- 58) The members of one of the chemical families exhibit the following characteristic reaction:



what is the name of the family?

- \*A) alkali metals
  - B) alkaline earth metals
  - C) noble metals
  - D) transition metals
- 59) Which one of the following statements about cesium is true?
- \*A) It is the most reactive non-radioactive element.
  - B) It is a poorer electrical conductor than is sodium.
  - C) It bonds covalently with members of the halogen family.
  - D) It has a higher first ionization energy than barium.
- 60) First ionization energies exhibit a decrease as one looks down a vertical column of the Periodic Table. The best explanation for this trend is
- \*A) on the average, valence electrons of heavier elements are farther from the nucleus than those of lighter elements
  - B) there is an increase in nuclear charge as one goes down a column of the Periodic Table
  - C) electrons of elements near the bottom of the Periodic Table have less mass
  - D) the nucleus becomes larger as one goes down a column of the Periodic Table

12A.12.

61) Which of the following statements is correct?

- A) Elements in the same family of the Periodic Table have the same ionization energy.
- B) The energy required to remove a second electron from an atom is less than that required to remove the first electron.
- C) The energy required to remove a third electron is less than that required to remove the second electron from an atom.
- \*D) The difficulty of removing successive electrons from an atom increases in a periodic pattern.

62) The element that is correctly identified according to family and period respectively is

- I Element 10 is a halogen in period II
- II Element 17 is a halogen in period III
- III Element 11 is an alkaline earth metal in period IV
- IV Element 21 is a transition metal in period III

- A) I is correct
- B) II is correct
- \*C) III is correct
- D) IV is correct

12A.12.

63) How many electrons are there in the outermost shell of a silicon atom?

- A) 6
- B) 2
- C) 8
- \*D) 4

64) The species in the following list that has the smallest atomic radius is a(n)

- A) sodium ion
- \*B) aluminum ion
- C) magnesium ion
- D) cesium ion

65) The highest second ionization energy would be expected for an atom with the electronic configuration

- A)  $1s^2 2s^2 2p^1$
- B)  $1s^2 2s^2 2p^5$
- C)  $1s^2 2s^2 2p^6$
- \*D)  $1s^2 2s^2 2p^6 3s^1$

12A.12.

66) Electrovalence is caused or explained most directly by

- A) the union of atoms of the same electronegativity, by the transfer of one or more electrons
- \*B) the transfer of one or more electrons between atoms of widely different electronegativity
- C) the sharing of electrons by atoms of similar electronegativity
- D) the sharing of electrons by atoms of widely different electronegativities

67) The ion in the following list that has the smallest radius is

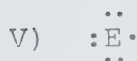
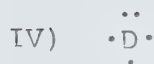
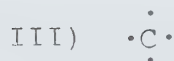
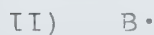
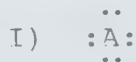
- \*A)  $\text{Mg}^{2+}$
- B)  $\text{Na}^{+}$
- C)  $\text{F}^{-}$
- D)  $\text{O}^{2-}$

68) Elements Q, R, X and T occur in the same period of the Periodic Table and have one, three, four and seven valence electrons, respectively. Which pair will form a compound that is most ionic?

- A) Q and R
- \*B) Q and T
- C) R and T
- D) R and X

12A.12.

69) Which of the following elements from row 3 of the Periodic Table would likely react with element V to form an ionic compound?



- \*A) I
- B) II
- C) III
- D) IV

70) The following diagram depicts a Periodic Table for a fictitious planet where there are only fourteen elements.

A					B
C	D	E	F	G	H
I	J	K	L	M	N

The most reactive group of metals consists of the elements

- \*A) C and I
- B) D and J
- C) B, H, and N
- D) G and M

12A.12.

71) As one reads down any column of the Periodic Table, ionization energy generally

- A) decreases and atomic number decreases
- \*B) decreases and atomic number increases
- C) increases and atomic number decreases
- D) increases and atomic number increases

72) Which one of the following statements concerning the third period elements is true?

- A) The metallic elements have the highest atomic numbers.
- \*B) The non-metallic elements tend to form covalent bonds with hydrogen.
- C) The metallic elements in this period tend to gain electrons during chemical reactions.
- D) The non-metallic elements tend to form positive ions during chemical reactions.

73) The following is the ground state electronic configuration of the valence electrons for an element in the periodic table:



This atoms belongs to

- A) period 4, group III
- \*B) period 3, group IV
- C) period 3, group II
- D) period 6, group IV

12A.12.

- 74) The following diagram depicts a "Periodic Table" for a fictitious planet where there are only fourteen elements.

A					B
C	D	E	F	G	H
I	J	K	L	M	N

The element with the highest ionization energy is

- A) A
  - \*B) B
  - C) I
  - D) N
- 75) Within a vertical group of elements in the Periodic Table, such as Group I, Li, Na, K, Rb, Cs, the first ionization energy
- A) increases with increasing atomic radius
  - \*B) decreases with increasing atomic radius
  - C) stays the same
  - D) behaves unpredictably
- 76) As the atomic number of the halogens, (F, Cl, Br, I) increases, the relative activity
- A) increases steadily
  - B) increases, then decreases
  - C) remains the same
  - \*D) decreases

12A.12.

- 77) Of the following, the element in the first group of the Periodic Table which has the lowest first ionization energy is
- A) sodium
  - B) potassium
  - C) rubidium
  - \*D) cesium
- 78) Within a vertical column in the Periodic Table, such as the halogens (F, Cl, Br, I), how does ionization energy change as atomic radius increases?
- A) It increases.
  - \*B) It decreases.
  - C) It stays the same.
  - D) Its behaviour cannot be predicted.
- 79) As the atomic numbers of the elements in a family of the Periodic Table increase, the
- A) atomic radii decrease
  - B) atomic masses decrease
  - \*C) ionization energies decrease
  - D) metallic characteristics decrease
- 80) Similar chemical properties are a result of similar elemental
- A) nuclear charges
  - \*B) outer electron shells
  - C) numbers of electron shells
  - D) physical properties

12A.12.

81) The element with the largest atomic radius is found at the bottom of

- \*A) group I
- B) group III
- C) group VI
- D) group VII

32) The element in the following list with the largest atomic diameter is

- A) Li
- B) Be
- C) N
- \*D) K

83) The species in the following list that has the smallest atomic radius is

- \*A)  $\text{Na}^+$
- B) Na
- C)  $\text{Na}^-$
- D)  $\text{K}^-$

84) In the Periodic Table, metallic characteristics decrease from

- A) right to left and bottom to top
- B) left to right and top to bottom
- C) right to left and top to bottom
- \*D) left to right and bottom to top

12A.12.

85) The element in the list with the largest atomic radius is

- A) Li
- B) K
- C) Cs
- \*D) Fr

86) Which of the following neutral atoms would lose electrons most easily?

- \*A) Cs
- B) Na
- C) F
- D) Be

87) On the Periodic Table, the radii of atoms

- A) increase from bottom to top
- \*B) increase from top to bottom
- C) do not change in a regular manner
- D) increase from left to right

88) Using a periodic table, and considering the atomic radii of

Nitrogen	7.5 nm	Arsenic	11.9 nm
Phosphorus	10.6 nm	Bismuth	14.6 nm

The atomic radius of Antimony is

- A) 12.0 nm
- \*B) 13.5 nm
- C) 15.0 nm
- D) 20.0 nm

12A.12.

- 89) The element in the following list with the largest atomic radius is
- \*A) Sn
  - B) As
  - C) S
  - D) F
- 90) In general the valence electrons of metals are
- A) few in number and strongly held
  - \*B) few in number and weakly held
  - C) many in number and strongly held
  - D) many in number and weakly held
- 91) To which group of the Periodic Table would element Z belong, if its third ionization energy is exceptionally high compared to its first and second ionization energies?
- A) I
  - \*B) II
  - C) III
  - D) V
- 92) In the Periodic Table, metallic character increases
- A) from left to right and top to bottom
  - B) from right to left and bottom to top
  - C) from bottom to top of a group
  - \*D) from top to bottom of a group

12A.12.

93) The most metallic element in the list below is

- A) calcium
- B) magnesium
- \*C) potassium
- D) sodium

94) Potassium is more reactive than sodium because it has a

- A) lower density than sodium
- B) smaller radius than sodium
- C) valence of +1
- \*D) lower ionization potential than sodium

95) Select the one correct relation between electronegativities of the following pairs of elements.

- A) K is greater than Ca
- B) Li is greater than N
- C) F is less than O
- \*D) S is less than O

96) Which one of the following statements best describes changes in the magnitude of the electronegativity of the elements in the Periodic Table.

- A) It increases from left to right in a row because the attraction of the nucleus for valence electrons decreases
- \*B) It increases from left to right in a row because the number of protons increases
- C) It decreases from left to right in a row because the number of electron shells increases
- D) It decreases because the number of valence shells increases from left to right in a particular row

12A.12.

- 97) From left to right across a period, the ionization energy of the elements
- \*A) increases
  - B) decreases
  - C) remains unchanged
  - D) changes irregularly
- 98) The dominant factor explaining the variation in the radius of successive atoms in a period is the
- \*A) increase in nuclear charge
  - B) increase in number of neutrons
  - C) change in metallic properties
  - D) addition of a principal energy level
- 99) The species in the following list with the smallest atomic radius is
- A) sodium
  - \*B) chlorine
  - C) potassium
  - D) sulfur
- 100) The electron configuration of the most active metal in the following is
- A) 2, 1
  - B) 2, 8, 3
  - \*C) 2, 8, 8, 1
  - D) 2, 7

12A.12.

- 101) The atomic radii decrease from left to right within a period of the Periodic Table because the
- A) number of electrons increases
  - B) number of protons decreases
  - C) atomic mass increases
  - \*D) electrostatic forces between the nucleus and the electrons increase
- 102) The electron arrangement in an atom expected to have the highest electron affinity is
- A) 2, 8
  - B) 2, 8, 1
  - C) 2, 6
  - \*D) 2, 7
- 103) The highest first electron affinity would be expected for the element whose electron configuration is represented by
- A)  $1s^2 2s^2 2p^1$
  - \*B)  $1s^2 2s^2 2p^5$
  - C)  $1s^2 2s^2 2p^6$
  - D)  $1s^2 2s^2 2p^6 3s^1$
- 104) The element in the following list which has the highest electronegativity is
- A) hydrogen
  - B) nitrogen
  - C) magnesium
  - \*D) fluorine

12A.12.

- 105) Elements Q, R, X and T occur in the same period of the Periodic Table and have one, three, four and seven valence electrons, respectively. Which element will most readily form a positive ion?
- \*A) Q
  - B) R
  - C) X
  - D) T
- 106) The first ionization energy of As is 987 kJ/mol. From the behaviour of the Li-Ne row of elements one would expect the first ionization energy for Se to be
- A) unrelated to that of arsenic
  - B) larger than that of arsenic
  - \*C) smaller than that of arsenic
  - D) equal to that of arsenic
- 107) Which of the following statements best describes the characteristics of the elements in the Periodic Table?
- A) The sequence of the elements Si, P, Cl shows increasing metallic character.
  - B) The sequence of the elements Li, Na, K shows decreasing metallic character.
  - \*C) The sequence of the elements C, N, O shows decreasing atomic radius.
  - D) The elements Ti, V, and Cr are non-metals.
- 108) The most electronegative element in the following list is
- A) chlorine
  - \*B) fluorine
  - C) oxygen
  - D) sulfur

12A.12.

109) The element in the list that has the greatest electronegativity is

- \*A) Li
- B) Na
- C) K
- D) Rb

110) The following diagram depicts a Periodic Table for a fictitious planet where there are only fourteen elements.

A					B
C	D	E	F	G	H
I	J	K	L	M	N

The element with the lowest ionization energy is

- A) A
- B) B
- \*C) I
- D) N

111) The element in the following list with the greatest electronegativity is

- A) N
- B) B
- C) C
- \*D) O

12A.12.

112) The first, second, third and fourth ionization energies of an element are 802 kJ/mol,  $2.43 \times 10^3$  kJ/mol,  $3.67 \times 10^3$  kJ/mol and  $2.39 \times 10^4$  kJ/mol respectively.

The element

- A) is a noble gas
- B) is a halogen
- \*C) has three valence electrons
- D) is an alkali metal

113) The element in the following list that has the largest electronegativity is

- A) Sn
- B) As
- C) S
- \*D) F

114) Which of the electron configurations listed corresponds to the element with the smallest atomic radius?

- A) 2, 8, 1
- B) 2, 8, 3
- C) 2, 8, 7
- \*D) 2, 8, 8

115) The element in the following list that has the highest first ionization energy is

- A) fluorine
- \*B) neon
- C) sodium
- D) magnesium

12A.12.

116) The metal in the following list that most readily loses electrons is

- \*A) calcium
- B) copper
- C) mercury
- D) tin

117) The electron arrangement expected to have the highest first ionization energy is

- A) 2, 6
- B) 2, 7
- \*C) 2, 8
- D) 2, 8, 1

x 118) The following diagram depicts a periodic table for a fictitious planet where there are only fourteen elements.

A					B
C	D	E	F	G	H
I	J	K	L	M	N

The element that has successive ionization energies of 630,  $1.68 \times 10^3$ ,  $5.04 \times 10^3$  and  $12.6 \times 10^5$  kJ/mol is

- A) I
- B) J
- \*C) K
- D) M

12A.12.

119) The element in the following list with the highest first ionization energy is

- A) O
- B) F
- \*C) Ne
- D) Na

120) Consider the electron configurations for elements W, X, Y and Z

Element	Electron Configuration
W	2,8,7
X	2,8,8
Y	2,8,8,1
Z	2,8,8,2

The atom having the largest atomic radius would be

- A) W
- B) X
- \*C) Y
- D) Z

(c) S-17D Statistical

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.1.1	12A.1.	**	395 249 928
12A.1.2	12A.1.	***	63 216 944
12A.1.3	12A.1.1.	*	484 880
12A.1.4	12A.1.1.		1039
12A.1.5	12A.1.1.	***	1138
12A.1.6	12A.1.1.		315 701 1208
12A.1.7	12A.1.1.	**	1147 741
12A.1.8	12A.1.1.	***	1039
12A.1.9	12A.1.1.	**	701 439
12A.1.10	12A.1.1.	**	943 818
12A.1.11	12A.1.1.	***	918
12A.1.12	12A.1.1.	**	1031
12A.1.13	12A.1.1.	***	315 701 1208
12A.1.14	12A.1.1.	**	941 943 818
12A.1.15	12A.1.1.	*	1184 1014 667
12A.1.16	12A.1.1.	**	315 701 1208
12A.1.17	12A.1.1.	***	853 891
12A.1.18	12A.1.1.	***	460 1184 78
12A.1.19	12A.1.1.		701
12A.1.20	12A.1.1.	***	741
12A.1.21	12A.1.1.	*	655 438
12A.1.22	12A.1.1.		439
12A.1.23	12A.1.1.	***	1182
12A.1.24	12A.1.1.	**	853 941
12A.1.25	12A.1.2.	***	739
12A.1.26	12A.1.2.	**	36 739
12A.1.27	12A.1.2.		937 249
12A.1.28	12A.1.2.	**	739
12A.1.29	12A.1.2.	**	937 891
12A.1.30	12A.1.2.		544 1061 739
12A.1.31	12A.1.2.	*	937 891
12A.1.32	12A.1.2.	**	739
12A.1.33	12A.1.2.		739
12A.1.34	12A.1.2.	**	739 249
12A.1.35	12A.1.3.	***	1139 739
12A.1.36	12A.1.3.	*	315 259 395
12A.1.37	12A.1.3.	*	867 249
12A.1.38	12A.1.3.	*	345
12A.1.39	12A.1.3.	**	867 701
12A.1.40	12A.1.3.	*	315 701 1208
12A.1.41	12A.1.3.	***	716
12A.1.42	12A.1.3.	***	1139 880 716 135
12A.1.43	12A.1.4.	*	395
12A.1.44	12A.1.4.		660 701
12A.1.45	12A.1.4.	**	249
12A.1.46	12A.1.4.	**	658 701
12A.1.47	12A.1.4.		658
12A.1.48	12A.1.4.	*	395
12A.1.49	12A.1.4.	*	249

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.1.50	12A.1.4.	**	395 214
12A.1.51	12A.1.4.	**	544
12A.1.52	12A.1.4.		395 249 739 1117
12A.1.53	12A.1.4.		659
12A.1.54	12A.1.4.	**	249
12A.1.55	12A.1.4.	*	395 249
12A.1.56	12A.1.5.	*	890
12A.1.57	12A.1.5.	**	207
12A.1.58	12A.1.5.	**	658
12A.1.59	12A.1.5.	*	207
12A.1.60	12A.1.5.	**	890
12A.1.61	12A.1.5.	**	890
12A.1.62	12A.1.5.	*	890
12A.1.63	12A.1.5.	***	890
12A.1.64	12A.1.5.	**	207
12A.1.65	12A.1.	**	207 701 924
12A.1.66	12A.1.	**	739 928 937
12A.1.67	12A.1.1.	***	941
12A.1.68	12A.1.2.	**	739
12A.1.69	12A.1.2.	*	701 707
12A.1.70	12A.1.2.	***	544 739 1061
12A.1.71	12A.1.2.	**	739 1117
12A.1.72	12A.1.4.	*	249 937
12A.1.73	12A.1.3.	**	313 1123
12A.1.73	12A.1.4.	**	660 701
12A.1.75	12A.1.4.	**	544 739 1061
12A.1.76	12A.1.5.	*	214
12A.1.77	12A.1.5.	*	890 891 937
12A.1.78	12A.1.5.	**	158 207
12A.1.79	12A.1.5.	***	248 723 847 979
12A.1.80	12A.1.5.	**	207
12A.1.81	12A.1.5.	*	302

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.2.1	12A.2.	*	1130
12A.2.2	12A.2.1.	**	764
12A.2.3	12A.2.1.	**	932
12A.2.4	12A.2.1.	*	376
12A.2.5	12A.2.1.	***	89
12A.2.6	12A.2.1.a	**	701 809 788 478
12A.2.7	12A.2.1.c	*	932 909 815 89
12A.2.8	12A.2.1.c	*	815 932 89
12A.2.9	12A.2.1.d	*	97 376
12A.2.10	12A.2.2.a	***	49 956
12A.2.11	12A.2.2.a	***	803 1011
12A.2.12	12A.2.2.a	**	788 1233 91 94
12A.2.13	12A.2.2.b	**	703 94 1233 91
12A.2.14	12A.2.2.b	**	94 376 785 89
12A.2.15	12A.2.2.b	**	91 94 788
12A.2.16	12A.2.2.b	**	788 91 94
12A.2.17	12A.2.2.b	**	91 94 1233 703
12A.2.18	12A.2.2.b	**	1233 91 94 703 788
12A.2.19	12A.2.2.b	*	97 91
12A.2.20	12A.2.2.b	*	1257 932 376 703 94
12A.2.21	12A.2.2.e.iv	***	93 170 701
12A.2.22	12A.2.2.b	*	932 376 89
12A.2.23	12A.2.3.a	**	605 703 94
12A.2.24	12A.2.2.b	**	91 932 722 701
12A.2.25	12A.2.2.c	***	670 44 1250 169
12A.2.26	12A.2.2.c	**	97 1233
12A.2.27	12A.2.2.c	*	408 1038 1255
12A.2.28	12A.2.2.c	*	1255 1035
12A.2.29	12A.2.2.c		1075 397 234 338 484
12A.2.30	12A.2.2.c	***	379 376 829
12A.2.31	12A.2.2.d	**	670 382
12A.2.32	12A.2.2.d	**	1250 169
12A.2.33	12A.2.2.d	*	130 384 380 97
12A.2.34	12A.2.2.e	**	91 1181 93
12A.2.35	12A.2.2.e	**	91 170
12A.2.36	12A.2.2.e	**	628 91 94 376 1233
12A.2.37	12A.2.2.e	**	628 1233 91 94
12A.2.38	12A.2.2.e	**	628 788
12A.2.39	12A.2.2.e	**	628 995 35
12A.2.40	12A.2.2.e	*	628 97
12A.2.41	12A.2.2.e	***	628 788
12A.2.42	12A.2.2.e	**	628 995
12A.2.43	12A.2.2.e	**	628 97
12A.2.44	12A.2.2.e	*	1283 91 94 628
12A.2.45	12A.2.2.e.ii	**	628 91 866 1233 955
12A.2.46	12A.2.2.e.iii	*	91 628 219 866 1233
12A.2.47	12A.2.2.e.iii	**	628 219 91 866 1233
12A.2.48	12A.2.3.	***	463 94
12A.2.49	12A.2.3.a	**	1049 1233 785 89
12A.2.50	12A.2.3.a	***	1255 1250 605
12A.2.51	12A.2.3.a	*	605 200
12A.2.52	12A.2.3.a	*	801 780 481

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.2.53	12A.2.3.a	**	605 613 1250
12A.2.54	12A.2.3.a	**	605 909 910 376
12A.2.55	12A.2.3.b	*	605 89 909 376
12A.2.55	12A.2.3.b	*	605 200 909 478 788
12A.2.57	12A.2.3.b	**	219 605 200 774 376
12A.2.58	12A.2.3.b	**	562 932 200 605
12A.2.59	12A.2.3.b	**	621 1167
12A.2.60	12A.2.3.b	***	621
12A.2.61	12A.2.3.b		605 377 1233
12A.2.62	12A.2.3.b	*	788 376 932 605 910
12A.2.63	12A.2.3.c	***	377 378 1255 481
12A.2.64	12A.2.3.c	***	392 688
12A.2.65	12A.2.3.c	**	801 1167 605 481
12A.2.66	12A.2.3.c	**	378 376 387
12A.2.67	12A.2.3.c	**	387
12A.2.68	12A.2.3.b	*	605 376 909 50
12A.2.69	12A.2.2.c	*	501 388 794
12A.2.70	12A.2.1.	*	815 376 809 89 478
12A.2.71	12A.2.3.a	*	605 200
12A.2.72	12A.2.2.b	*	376 932 98
12A.2.73	12A.2.2.b	***	788 94 703
12A.2.74	12A.2.2.b	**	788 94 703
12A.2.75	12A.2.2.d	**	382 670 1234
12A.2.76	12A.2.1.	***	202
12A.2.77	12A.2.3.b	**	932 562
12A.2.78	12A.2.2.e	***	93 1181
12A.2.79	12A.2.1.d		96
12A.2.80	12A.2.2.c		97 131
12A.2.81	12A.2.2.b		94 98 788 815
12A.2.82	12A.2.2.e		628 384 97 91
12A.2.83	12A.2.3.a		1250 234
12A.2.84	12A.2.2.c		1193
12A.2.85	12A.2.2.e		628 320 1175
12A.2.86	12A.2.2.b		94 932 376 703 788
12A.2.87	12A.2.2.e		89 91 94 932
12A.2.88	12A.2.3.c		234 1250
12A.2.89	12A.2.3.b		1255 605
12A.2.90	12A.2.3.c		392 1167 874
12A.2.91	12A.2.2.e	**	628 788
12A.2.92	12A.2.2.e	**	91 628 866 995
12A.2.93	12A.2.2.e	**	478 1233
12A.2.94	12A.2.2.e	***	628 932 703
12A.2.95	12A.2.2.e	**	1233 788 815
12A.2.96	12A.2.2.e	**	628 995 91 866
12A.2.97	12A.2.2.e	**	628 932
12A.2.98	12A.2.2.e	**	1233 788 376 785
12A.2.99	12A.2.2.e	**	628 91 866 1233 995
12A.2.100	12A.2.2.e	**	995
12A.2.101	12A.2.2.e	**	628 932 94 91
12A.2.102	12A.2.2.e	*	628 94 91
12A.2.103	12A.2.2.e	*	170 91
12A.2.104	12A.2.2.e	**	815 932 815 1175

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.2.105	12A.2.2.e	**	628 94 557
12A.2.106	12A.2.2.e	**	320 628 557
12A.2.107	12A.2.2.e	**	91 995
12A.2.108	12A.2.2.e	**	628 788
12A.2.109	12A.2.2.e	**	995 170
12A.2.110	12A.2.2.e	*	170 995 91
12A.2.111	12A.2.2.e	*	703 788 932
12A.2.112	12A.2.2.e	***	628 995
12A.2.113	12A.2.2.e	**	628 94
12A.2.114	12A.2.2.e	**	628 788 701
12A.2.115	12A.2.2.e	**	91 995 628
12A.2.116	12A.2.2.e	**	628 788 701
12A.2.117	12A.2.2.e	***	628 1233 1175
12A.2.118	12A.2.2.e	**	703 932 788
12A.2.119	12A.2.2.e	**	628 995
12A.2.120	12A.2.2.e	***	93 1181 170
12A.2.121	12A.2.2.e	**	628 94 703
12A.2.122	12A.2.2.e	**	320 1233
12A.2.123	12A.2.2.e	**	628 815 932 1233
12A.2.124	12A.2.2.e	***	170 995
12A.2.125	12A.2.2.e	***	91 788 703
12A.2.126	12A.2.2.e	**	628 995 170
12A.2.127	12A.2.2.e	***	91 628 170
12A.2.128	12A.2.2.e.i	***	628 320
12A.2.129	12A.2.2.e.i	*	628 701 274
12A.2.130	12A.2.2.e.i	**	628 995 219
12A.2.131	12A.2.2.e.i	*	170
12A.2.132	12A.2.2.e	**	788 703 628
12A.2.133	12A.2.3.	***	200 460 100
12A.2.134	12A.2.2.a	***	1009 1010
12A.2.135	12A.2.2.b	**	94 932
12A.2.136	12A.2.2.b	**	94 932 788 376
12A.2.137	12A.2.2.c	*	1250 696
12A.2.138	12A.2.2.c	***	38 829 1016
12A.2.139	12A.2.2.e	***	170 91 853
12A.2.140	12A.2.2.e	***	38 387 1250
12A.2.141	12A.2.3.b	***	605 620 696
12A.2.142	12A.2.3.	**	605 218
12A.2.143	12A.2.2.e	**	628 179 932 788
12A.2.144	12A.2.2.c	*	501 388 38
12A.2.145	12A.2.2.c	*	94 478
12A.2.146	12A.2.2.c	*	94 388
12A.2.147	12A.2.2.c	**	1075 397
12A.2.148	12A.2.2.c	*	831 949
12A.2.149	12A.2.2.c	*	388 1250
12A.2.150	12A.2.2.c	*	932 376 89 815
12A.2.151	12A.2.2.c	*	501 388 853
12A.2.152	12A.2.3.a	***	605 1234
12A.2.153	12A.2.2.c	*	1293 388 794
12A.2.154	12A.2.2.c	**	388 801
12A.2.155	12A.2.2.c	*	388 841 1195
12A.2.156	12A.2.2.c	*	417

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.2.157	12A.2.2.c	*	376 408 949
12A.2.158	12A.2.2.c	**	388 794
12A.2.159	12A.2.3.	***	388 621 622 1250
12A.2.160	12A.2.2.c	**	408 949 376 388 1250
12A.2.161	12A.2.3.a	**	388 605 1250
12A.2.162	12A.2.2.c	**	408 949 376 388 1250
12A.2.163	12A.2.2.c	*	388 94 1250
12A.2.164	12A.2.2.d	***	388 1250 1028 832
12A.2.165	12A.2.2.d	**	388 1250 1028 670
12A.2.166	12A.2.2.d	*	388 1250 1028 832
12A.2.167	12A.2.2.d	***	388 1250 1028 670
12A.2.168	12A.2.2.d	**	388 1250 1028 832
12A.2.169	12A.2.3.a	*	605 200 89
12A.2.170	12A.2.3.a	*	605 359
12A.2.171	12A.2.3.a	*	605 376 910
12A.2.172	12A.2.3.a	**	853 605 932 376
12A.2.173	12A.2.3.a	**	1234
12A.2.174	12A.2.3.a	***	620
12A.2.175	12A.2.3.a	***	605 94 703 91
12A.2.176	12A.2.3.a	***	478 605
12A.2.177	12A.2.3.a	**	605 1083 120
12A.2.178	12A.2.3.a	*	605 688 504 696
12A.2.179	12A.2.3.b	*	1049 605 688
12A.2.180	12A.2.3.b	*	605 164
12A.2.181	12A.2.3.b	*	605 376
12A.2.182	12A.2.3.b	**	605 1234
12A.2.183	12A.2.3.b	*	605 376
12A.2.184	12A.2.3.b	*	605 1234
12A.2.185	12A.2.3.b	**	910 187
12A.2.186	12A.2.3.b	***	616 605
12A.2.187	12A.2.3.b	***	605 616 779 780
12A.2.188	12A.2.3.c	**	621 622
12A.2.189	12A.2.3.c	***	387 388
12A.2.190	12A.2.3.c	**	801
12A.2.191	12A.2.3.c	***	621 874 1167
12A.2.192	12A.2.3.c	***	1083 588 874
12A.2.193	12A.2.3.c	**	622
12A.2.194	12A.2.3.c	**	874 621
12A.2.195	12A.2.3.c	***	621 874 130
12A.2.196	12A.2.3.c	***	95 605 616
12A.2.197	12A.2.3.c	*	621
12A.2.198	12A.2.3.c	**	387 377
12A.2.199	12A.2.3.c	**	378 377
12A.2.200	12A.2.3.c	***	611 147
12A.2.201	12A.2.3.c	***	727 392
12A.2.202	12A.2.3.c	**	621
12A.2.203	12A.2.2.c	*	213 841
12A.2.204	12A.2.1.	*	97 809 932
12A.2.205	12A.2.1.	*	94 932
12A.2.206	12A.2.1.a	**	97 605 701
12A.2.207	12A.2.2.a	*	89 97 815
12A.2.208	12A.2.2.a	***	803 1011

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.2.209	12A.2.2.a	***	1009 1011
12A.2.210	12A.2.2.c	***	832 947 949
12A.2.211	12A.2.2.b	**	97
12A.2.212	12A.2.2.c	*	91 94 97
12A.2.213	12A.2.2.e	**	1 91 94 97 1230
12A.2.214	12A.2.2.e	*	866 867
12A.2.215	12A.2.2.e	*	97 628 809
12A.2.216	12A.2.2.e	**	91 628 995
12A.2.217	12A.2.2.e	*	94
12A.2.218	12A.2.2.e	**	94 628
12A.2.219	12A.2.2.e	**	94 628 1233
12A.2.220	12A.2.2.e	**	376 628
12A.2.221	12A.2.2.e	**	97 628
12A.2.222	12A.2.2.e	**	376 628
12A.2.223	12A.2.2.e	***	393 947
12A.2.224	12A.2.2.e	*	628 703
12A.2.225	12A.2.2.e	***	91 628
12A.2.226	12A.2.2.e	***	214 628
12A.2.227	12A.2.2.e	**	91 94 798
12A.2.228	12A.2.2.e	**	91 94 932
12A.2.229	12A.2.2.e	*	91
12A.2.230	12A.2.2.e	***	388 628
12A.2.231	12A.2.2.e	***	91 628
12A.2.232	12A.2.2.e	**	628 703 932
12A.2.233	12A.2.3.a	**	398 605
12A.2.234	12A.2.3.a	**	722 727
12A.2.235	12A.2.3.a	***	388 605
12A.2.236	12A.2.3.a	**	376 605
12A.2.237	12A.2.3.a	*	68 605 780
12A.2.238	12A.2.3.a	**	376 605
12A.2.239	12A.2.3.a	*	794 874 986
12A.2.240	12A.2.3.a	***	215 388 801 986
12A.2.241	12A.2.3.c	**	376 605 801
12A.2.242	12A.2.3.b	*	376 605
12A.2.243	12A.2.3.a	***	388 621
12A.2.244	12A.2.3.a	*	388 986
12A.2.245	12A.2.3.a	**	605 1234 200 359
12A.2.246	12A.2.3.a	**	214 722 979
12A.2.247	12A.2.3.a	**	94 605
12A.2.248	12A.2.3.a	***	621
12A.2.249	12A.2.3.a	**	445 620 873 1233
12A.2.250	12A.2.3.c	**	445 722 873 1233
12A.2.251	12A.2.3.c	**	605 722

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.3.1	12A.3.3.a	***	387 147
12A.3.2	12A.3.3.a		147 387 376
12A.3.3	12A.3.4.b	***	279 147 219
12A.3.4	12A.3.4.c	*	670 382 56
12A.3.5	12A.3.5.a	**	169 46
12A.3.6	12A.3.4.b	***	147 460
12A.3.7	12A.3.3.b	**	617 147
12A.3.8	12A.3.5.b	***	147 784
12A.3.9	12A.3.3.c	*	611 147
12A.3.10	12A.3.	***	1053 716 147
12A.3.11	12A.3.6.a	*	722
12A.3.12	12A.3.5.b	***	282 278 46 169 324
12A.3.13	12A.3.4.c	***	753 172 679
12A.3.14	12A.3.4.b	***	279 249
12A.3.15	12A.3.4.d	***	670 382
12A.3.16	12A.3.5.b	***	46 169 287
12A.3.17	12A.3.5.		784 147
12A.3.18	12A.3.6.b	**	725 147
12A.3.19	12A.3.4.b	**	764 766
12A.3.20	12A.3.3.	**	611
12A.3.21	12A.3.7.	**	1037 753
12A.3.22	12A.3.4.d	***	670 282 346 835 640
12A.3.23	12A.3.4.b	***	899 147
12A.3.24	12A.3.4.e	***	279 147
12A.3.25	12A.3.5.b	***	761 1197 147 172
12A.3.26	12A.3.6.a	***	722 909
12A.3.27	12A.3.5.a	**	1043 279
12A.3.28	12A.3.4.a	**	764
12A.3.29	12A.3.4.b	**	279 278 1053
12A.3.30	12A.3.4.b	*	1037 753 172 901 802
12A.3.31	12A.3.3.a		611 147 376
12A.3.32	12A.3.2.	**	176 725 1197 147
12A.3.33	12A.3.3.a	*	617 612 147
12A.3.34	12A.3.4.c	***	670 382 1109 145
12A.3.35	12A.3.1.	*	484 147 1096
12A.3.36	12A.3.2.	***	1196
12A.3.37	12A.3.5.b	**	286 651
12A.3.38	12A.3.3.		611 343 605 258 618
12A.3.39	12A.3.6.	*	722 725 259
12A.3.40	12A.3.5.	*	784 282
12A.3.41	12A.3.	***	764 794 766
12A.3.42	12A.3.5.b	***	281 324
12A.3.43	12A.3.1.	***	761 147
12A.3.44	12A.3.7.	***	764
12A.3.45	12A.3.2.		1212 559
12A.3.46	12A.3.4.b	*	613
12A.3.47	12A.3.3.a	***	605 611 147 438
12A.3.48	12A.3.3.a	**	611 147
12A.3.49	12A.3.3.a	***	611
12A.3.50	12A.3.3.a	***	605 620 754 106
12A.3.51	12A.3.3.b	***	900 147 376
12A.3.52	12A.3.3.b	***	11 394

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.3.53	12A.3.4.d	**	332 1212
12A.3.54	12A.3.1.	***	764 207
12A.3.55	12A.3.4.a	**	764 279
12A.3.56	12A.3.4.b		388
12A.3.57	12A.3.4.b		900 898
12A.3.58	12A.3.4.b	**	280
12A.3.59	12A.3.4.b	*	279 376
12A.3.60	12A.3.4.b	**	278 249
12A.3.61	12A.3.4.b	**	802 1054
12A.3.62	12A.3.4.b	**	279 376 1192
12A.3.63	12A.3.4.c	**	670 1250
12A.3.64	12A.3.4.c	***	670 44 1250 169
12A.3.65	12A.3.4.d		147 135
12A.3.66	12A.3.4.d	***	172 670 382 346
12A.3.67	12A.3.4.d	**	282 670 1173
12A.3.68	12A.3.4.d	**	670 382 346 835
12A.3.69	12A.3.4.d	***	1174
12A.3.70	12A.3.4.b	***	1197 147
12A.3.71	12A.3.4.f	***	387
12A.3.72	12A.3.4.f	***	597 1237
12A.3.73	12A.3.5.a	**	169 46 324 499
12A.3.74	12A.3.5.a	*	279
12A.3.75	12A.3.5.a	**	281 324
12A.3.76	12A.3.5.a	***	279 388 1250
12A.3.77	12A.3.5.b		617 784 285
12A.3.78	12A.3.5.b		281 928
12A.3.79	12A.3.6.	***	722 725
12A.3.80	12A.3.6.		37 38 1254
12A.3.81	12A.3.6.a	***	722 147 725 376
12A.3.82	12A.3.6.a	*	274 260 722
12A.3.83	12A.3.6.a	***	724 285 651
12A.3.84	12A.3.6.a	**	722 725
12A.3.85	12A.3.6.a	***	725 147 724 285
12A.3.86	12A.3.6.b	*	722 259
12A.3.87	12A.3.6.b	**	726
12A.3.88	12A.3.2.	**	764
12A.3.89	12A.3.4.c	*	94 382 670
12A.3.90	12A.3.a	*	95 96 388
12A.3.91	12A.3.2.	*	30 614
12A.3.92	12A.3.4.b	***	460 597
12A.3.93	12A.3.3.a	**	258 363 617
12A.3.94	12A.3.2.	**	784
12A.3.95	12A.3.2.	*	722
12A.3.96	12A.3.6.a	**	258 784 1054
12A.3.97	12A.3.4.c	***	135 556 764
12A.3.98	12A.3.5.b	***	147 279
12A.3.99	12A.3.6.a	**	722 891
12A.3.100	12A.3.6.a	***	722 891
12A.3.101	12A.3.3.a	**	30 614 621 1193
12A.3.102	12A.3.3.a	**	30 614
12A.3.103	12A.3.3.b	**	147 611 612
12A.3.104	12A.3.4.c	*	605 619

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.3.105	12A.3.4.a	**	89 463
12A.3.106	12A.3.4.a	*	89 463
12A.3.107	12A.3.4.a	***	89 463
12A.3.108	12A.3.4.a	*	89 463
12A.3.109	12A.3.4.b	***	147 206
12A.3.110	12A.3.4.a	**	84 463
12A.3.111	12A.3.4.a	*	463 816
12A.3.112	12A.3.4.a	*	89 463
12A.3.113	12A.3.4.b	***	147 278
12A.3.114	12A.3.4.b	*	147 278 279
12A.3.115	12A.3.4.b	*	822 841 1195
12A.3.116	12A.3.4.b	**	279
12A.3.117	12A.3.4.b	*	279
12A.3.118	12A.3.4.b	*	279
12A.3.119	12A.3.4.d	**	147 1173
12A.3.120	12A.3.4.c	*	733 1144
12A.3.121	12A.3.4.c	*	1110
12A.3.122	12A.3.4.f	**	138 142 147
12A.3.123	12A.3.4.f	***	141 405
12A.3.124	12A.3.4.c	***	382 670 463

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.4.1	12A.4.3.d	***	1199 1141
12A.4.2	12A.4.	***	1199
12A.4.3	12A.4.1.e	***	1208 918 645
12A.4.4	12A.4.2.	***	268 715 196
12A.4.5	12A.4.2.c	*	1115
12A.4.6	12A.4.2.c	**	1115 880 1094
12A.4.7	12A.4.3.c	*	430 880
12A.4.8	12A.4.3.d	**	861
12A.4.9	12A.4.4.	***	764 484 645
12A.4.10	12A.4.4.	**	5 1138 639
12A.4.11	12A.4.4.a	**	918 645
12A.4.12	12A.4.4.a	***	579 484 918 1138
12A.4.13	12A.4.4.b	*	645 1138
12A.4.14	12A.4.4.c	***	645 643
12A.4.15	12A.4.4.c	**	104 105
12A.4.16	12A.4.4.d	**	152 315 197
12A.4.17	12A.4.4.e	***	203 1235
12A.4.18	12A.4.4.f	*	203 1138 486
12A.4.19	12A.4.4.f	**	486 1208
12A.4.20	12A.4.4.f	**	486 1208 199
12A.4.21	12A.4.4.f	*	486 152 197
12A.4.22	12A.4.4.f	***	315 484
12A.4.23	12A.4.4.f	**	484 701
12A.4.24	12A.4.4.f	**	486 1208 199
12A.4.25	12A.4.3.d	***	1199 1141
12A.4.26	12A.4.3.d	**	1199 1141
12A.4.27	12A.4.1.	*	680 484 1096 1166
12A.4.28	12A.4.4.a	*	495 329 486 646
12A.4.29	12A.4.4.c	*	104 105 486
12A.4.30	12A.4.2.	*	1096 1053
12A.4.31	12A.4.3.d	*	1199
12A.4.32	12A.4.4.b	*	152 645 484
12A.4.33	12A.4.4.	*	918 645
12A.4.34	12A.4.3.	***	1199 1141
12A.4.35	12A.4.4.d	*	918 486 152
12A.4.36	12A.4.4.e	***	315 203
12A.4.37	12A.4.4.f	*	315 484 1015
12A.4.38	12A.4.4.f	*	315 1015 484
12A.4.39	12A.4.4.a	***	495 329 486 646
12A.4.40	12A.4.3.b	***	468 1208 1212
12A.4.41	12A.4.2.c	***	880 1138
12A.4.42	12A.4.2.	*	1115
12A.4.43	12A.4.4.b	***	762 495
12A.4.44	12A.4.4.c	***	104 105
12A.4.45	12A.4.4.	*	645 203 484
12A.4.46	12A.4.3.	*	345 890 880
12A.4.47	12A.4.4.e	*	203 1208 486
12A.4.48	12A.4.4.d	*	152 486 1208
12A.4.49	12A.4.4.f	**	486 152
12A.4.50	12A.4.4.f	***	1208 1015 701 484
12A.4.51	12A.4.4.c	*	104 105
12A.4.52	12A.4.2.c.i		1115 1212 1094

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.4.53	12A.4.1.	**	680 1203 1166 1007
12A.4.54	12A.4.3.d	*	861
12A.4.55	12A.4.1.	*	764 645
12A.4.56	12A.4.3.c	**	256 434 1094
12A.4.57	12A.4.4.d	**	152
12A.4.58	12A.4.4.f	**	645 198
12A.4.59	12A.4.4.f	*	1208 203 486 199
12A.4.60	12A.4.	*	700 487
12A.4.61	12A.4.4.f	**	1208 486 199
12A.4.62	12A.4.2.	*	534 268
12A.4.63	12A.4.4.f		152 1208
12A.4.64	12A.4.4.d	***	645 701 918
12A.4.65	12A.4.4.b	***	1201 762 643
12A.4.66	12A.4.4.f	***	486 1208 1015
12A.4.67	12A.4.4.a	***	298 861
12A.4.68	12A.4.4.e		495
12A.4.69	12A.4.3.	***	1198 415
12A.4.70	12A.4.4.e	**	203 1235 1208
12A.4.71	12A.4.1.	*	645
12A.4.72	12A.4.4.a	***	762 172 1212 643
12A.4.73	12A.4.4.b	*	643 645 758
12A.4.74	12A.4.4.	**	579 484 1254 486
12A.4.75	12A.4.4.f	***	486 1015 1208
12A.4.76	12A.4.4.	*	484 339 1258
12A.4.77	12A.4.4.f	*	104 105
12A.4.78	12A.4.4.f	**	152 1208 486
12A.4.79	12A.4.4.	*	484 645 65
12A.4.80	12A.4.4.e	**	203 1235 486
12A.4.81	12A.4.4.b	***	645 1138 643
12A.4.82	12A.4.4.f	*	486 918
12A.4.83	12A.4.4.d	*	152 1208
12A.4.84	12A.4.4.b	*	762 643 484
12A.4.85	12A.4.4.a	**	484 918 230
12A.4.86	12A.4.4.e	*	645 152
12A.4.87	12A.4.4.a	**	1166 484 645
12A.4.88	12A.4.1.	*	486 645
12A.4.89	12A.4.4.f	**	315 203 1235
12A.4.90	12A.4.4.b	***	495 762
12A.4.91	12A.4.3.c	**	134 1138
12A.4.92	12A.4.4.f	**	486 1015 1208
12A.4.93	12A.4.4.f	**	315 203 1235
12A.4.94	12A.4.	**	203 579
12A.4.95	12A.4.4.c	**	579 749 1208
12A.4.96	12A.4.1.	*	30 879
12A.4.97	12A.4.1.	**	758 1166
12A.4.98	12A.4.1.	**	152 484 486
12A.4.99	12A.4.2.c	*	880 115
12A.4.100	12A.4.2.c	**	715 716 880 937
12A.4.101	12A.4.2.c	**	880 1237
12A.4.102	12A.4.3.	**	256 345 430
12A.4.103	12A.4.3.a	**	1053 1096
12A.4.104	12A.4.3.a	**	484 928 1096

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.4.105	12A.4.3.d	***	1141 1199
12A.4.106	12A.4.3.d	**	298 861 1199
12A.4.107	12A.4.4.a	***	700
12A.4.108	12A.4.4.a	*	30 484
12A.4.109	12A.4.4.a	*	110 487
12A.4.110	12A.4.4.c	***	104 557 643 762 853
12A.4.111	12A.4.4.b	**	102 105 486 643
12A.4.112	12A.4.4.b	***	486 643 645
12A.4.113	12A.4.4.b	***	315 329 495
12A.4.114	12A.4.4.b	***	104 105 495
12A.4.115	12A.4.4.b	*	230 232 643
12A.4.116	12A.4.4.c	**	104 105
12A.4.117	12A.4.4.c	**	104 105 486
12A.4.118	12A.4.4.c	**	105 106 486 1015
12A.4.119	12A.4.4.c	**	104
12A.4.120	12A.4.4.d	***	152 486
12A.4.121	12A.4.4.d	**	152
12A.4.122	12A.4.4.e	**	230 486
12A.4.123	12A.4.4.e	**	189 639 1138
12A.4.124	12A.4.4.f	**	197 203 486 752
12A.4.125	12A.4.4.f	**	152 197 198 201 486
12A.4.126	12A.4.4.f	**	198 203 232
12A.4.127	12A.4.4.f	**	152 203 486
12A.4.128	12A.4.4.f	**	230 231 486
12A.4.129	12A.4.4.f	***	203 486
12A.4.130	12A.4.4.f	***	152 486
12A.4.131	12A.4.4.f	**	197 298 486
12A.4.132	12A.4.4.f	**	484 701 764
12A.4.133	12A.4.4.f	***	152 315 484
12A.4.134	12A.4.4.f	**	203 486 1235
12A.4.135	12A.4.4.e	***	203 486
12A.4.136	12A.4.4.f	***	1054 1212

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.5.1	12A.5.1.	**	404 302
12A.5.2	12A.5.1.	*	214 405
12A.5.3	12A.5.2.b	*	181
12A.5.4	12A.5.3.	*	853 819
12A.5.5	12A.5.3.c	**	853 681 1067
12A.5.6	12A.5.3.a	*	889 172
12A.5.7	12A.5.3.b	***	853 926 649
12A.5.8	12A.5.3.c	*	681 256
12A.5.9	12A.5.3.c	***	681 853 135
12A.5.10	12A.5.3.c		681 1067
12A.5.11	12A.5.3.c		240 463 1049
12A.5.12	12A.5.4.a	**	847 928
12A.5.13	12A.5.4.a	***	240
12A.5.14	12A.5.4.d	*	1008 624
12A.5.15	12A.5.4.a	**	463 847 1192
12A.5.16	12A.5.4.b	***	240 979
12A.5.17	12A.5.4.b	***	624 240 853 1008
12A.5.18	12A.5.4.b	***	240 169
12A.5.19	12A.5.4.b	***	240 924
12A.5.20	12A.5.4.b	*	172 240
12A.5.21	12A.5.5.	**	19 801 847
12A.5.22	12A.5.5.a	***	19 847 886
12A.5.23	12A.5.5.a	*	696 847 985 112 114
12A.5.24	12A.5.6.a	***	882
12A.5.25	12A.5.7.	**	557 928
12A.5.26	12A.5.7.b	**	732 38
12A.5.27	12A.5.7.b	***	722 557 926 1212
12A.5.28	12A.5.7.b	**	557 926 624
12A.5.29	12A.5.8.a	***	557 853 1212 1208 429
12A.5.30	12A.5.8.a	**	1212 432
12A.5.31	12A.5.8.b	*	557 274 847 1212 992
12A.5.32	12A.5.8.b	***	990 557 988
12A.5.33	12A.5.9.	*	274 983
12A.5.34	12A.5.9.	**	26 722 339
12A.5.35	12A.5.9.	***	722 26 27
12A.5.36	12A.5.9.		
12A.5.37	12A.5.9.	***	722 26 27
12A.5.38	12A.5.8.b	**	843 557 414 989
12A.5.39	12A.5.5.a	***	114 847
12A.5.40	12A.5.4.b	**	172 674 240
12A.5.41	12A.5.3.c	**	853 681 466
12A.5.42	12A.5.8.a	*	557 240 1212
12A.5.43	12A.5.4.a	***	240 696 847
12A.5.44	12A.5.7.a	**	557 819 35
12A.5.45	12A.5.1.	**	214
12A.5.46	12A.5.	**	181
12A.5.47	12A.5.5.	**	722 847 114 115
12A.5.48	12A.5.9.	***	26 557 339
12A.5.49	12A.5.6.	***	434 853
12A.5.50	12A.5.4.c	***	240
12A.5.51	12A.5.	*	181 971
12A.5.52	12A.5.1.	*	207 214 406

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.5.53	12A.5.1.	*	214 431 434 1149
12A.5.54	12A.5.1.	**	404 1149
12A.5.55	12A.5.2.	*	
12A.5.56	12A.5.3.b	*	273 853
12A.5.57	12A.5.3.b	*	853 899
12A.5.58	12A.5.3.c	***	315 853 1054
12A.5.59	12A.5.3.c	***	485 853 926
12A.5.60	12A.5.3.c	***	73 681 853
12A.5.61	12A.5.4.a	***	26 847 1192
12A.5.62	12A.5.4.b	***	556 835
12A.5.63	12A.5.4.b	*	172 674 1143
12A.5.64	12A.5.4.b	**	240 414
12A.5.65	12A.5.4.c	***	642 886
12A.5.66	12A.5.5.a	***	114 722 847
12A.5.67	12A.5.5.a	***	111 116 722 847
12A.5.68	12A.5.4.a	***	436 941 942
12A.5.69	12A.5.7.a	***	395 819
12A.5.70	12A.5.7.b	**	111 485 557 561 722
12A.5.71	12A.5.7.c	**	835 1236
12A.5.72	12A.5.8.a	***	147 460 557 597
12A.5.73	12A.5.8.a	**	557 891
12A.5.74	12A.5.9.	***	38 722 1049
12A.5.75	12A.5.9.	**	485 557 722 983
12A.5.76	12A.5.9.	**	722
12A.5.77	12A.5.9.	**	111 722 847 985 1212
12A.5.78	12A.5.9.	**	11 111 847
12A.5.79	12A.5.3.b	***	853 1067 649 181
12A.5.80	12A.5.3.b	**	303 720
12A.5.81	12A.5.4.a	*	847 463 696 1192 240
12A.5.82	12A.5.4.a	**	696 1212 240 114
12A.5.83	12A.5.3.b	***	853 649 926 181
12A.5.84	12A.5.5.a	***	114 113 847
12A.5.85	12A.5.7.a		562 566
12A.5.86	12A.5.8.a	**	429 561
12A.5.87	12A.5.1.	***	404
12A.5.88	12A.5.5.	***	19 801 847
12A.5.89	12A.5.4.	*	853 1143 240
12A.5.90	12A.5.9.	***	26 1124
12A.5.91	12A.5.5.a	*	847 985 21 18 19
12A.5.92	12A.5.4.a	*	240 853
12A.5.93	12A.5.8.a	***	583 1143
12A.5.94	12A.5.3.b	*	339 1212 484 1054 1057
12A.5.95	12A.5.8.b	***	274 853
12A.5.96	12A.5.4.c	**	1081 1045
12A.5.97	12A.5.4.c	*	434
12A.5.98	12A.5.3.	*	853 1143
12A.5.99	12A.5.5.a	***	115 722 847
12A.5.100	12A.5.9.	**	1212 557 649

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.6.1	12A.6.1.	**	105 486
12A.6.2	12A.6.1.		751 749 701
12A.6.3	12A.6.1.	**	367 751 979 438
12A.6.4	12A.6.1.	**	749 751
12A.6.5	12A.6.1.	***	367 751 979 438
12A.6.6	12A.6.1.		751 103 816
12A.6.7	12A.6.1.	**	749 751
12A.6.8	12A.6.1.	*	749 751
12A.6.9	12A.6.1.	***	486 751 995
12A.6.10	12A.6.2.b	**	749 89 701
12A.6.11	12A.6.2.b	**	751 749 701
12A.6.12	12A.6.3.b	*	749 995
12A.6.13	12A.6.3.b	*	749 995 643
12A.6.14	12A.6.3.b	***	749 701
12A.6.15	12A.6.3.b	*	749 701
12A.6.16	12A.6.3.b	**	749
12A.6.17	12A.6.3.b	**	749 751 701
12A.6.18	12A.6.3.b	**	995 701 751 219
12A.6.19	12A.6.3.b	**	749 701 995
12A.6.20	12A.6.3.b	***	749 701 103
12A.6.21	12A.6.3.c	***	104 105 750
12A.6.22	12A.6.3.c	***	104 105
12A.6.23	12A.6.3.c	***	749 104 105 463
12A.6.24	12A.6.3.c	***	486 751 103
12A.6.25	12A.6.3.c	**	663 763
12A.6.26	12A.6.3.c	**	750 995
12A.6.27	12A.6.3.d	***	750 1015
12A.6.28	12A.6.3.d	***	1208 750 995 701
12A.6.29	12A.6.3.d	*	750 1015 579
12A.6.30	12A.6.3.d	*	104 105 749
12A.6.31	12A.6.3.e	***	749 995
12A.6.32	12A.6.3.e	***	701 749 750
12A.6.33	12A.6.3.e	*	749 751
12A.6.34	12A.6.3.e.ii	**	104 105 749 995
12A.6.35	12A.6.3.e.ii	***	486 751 995 749
12A.6.36	12A.6.4.e	*	756 1176 1041 401 701
12A.6.37	12A.6.4.c		756 1176 866 995 1208
12A.6.38	12A.6.4.c	*	756 1176 401 1041
12A.6.39	12A.6.2.b	**	749 751
12A.6.40	12A.6.2.b	*	749 751
12A.6.41	12A.6.3.d	*	750 751
12A.6.42	12A.6.4.a	**	869
12A.6.43	12A.6.4.a	*	749 995
12A.6.44	12A.6.3.d	*	496 750
12A.6.45	12A.6.3.c	***	749 816 701
12A.6.46	12A.6.3.c	*	750 751 103
12A.6.47	12A.6.4.d	*	463 816
12A.6.48	12A.6.4.a	*	866 701 1061
12A.6.49	12A.6.4.a	**	701 643 866
12A.6.50	12A.6.4.a	**	866 995
12A.6.51	12A.6.4.a	**	866 847
12A.6.52	12A.6.4.a	**	1239 701 1212

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.6.53	12A.6.4.a	*	463 866 995
12A.6.54	12A.6.4.b	***	1041 401 866
12A.6.55	12A.6.4.b	*	401 1041 866 995
15A.6.56	12A.6.4.b	***	1041 401 866 701
12A.6.57	12A.6.4.b	***	1041 401 866
12A.6.58	12A.6.4.b	**	1041 401 995
12A.6.59	12A.6.4.b	**	1041 401
12A.6.60	12A.6.4.b	**	1041 401 701
12A.6.61	12A.6.4.c	**	1176 1041 756 401 1239
126.6.62	12A.6.4.c		1041 401
12A.6.63	12A.6.4.c	***	756 1176 1041 401 486
12A.6.64	12A.6.4.c	**	756 1176 866 749
12A.6.65	12A.6.4.c	**	749 1176 401 756 1041
12A.6.66	12A.6.4.c	*	1041 401 756 1176
12A.6.67	12A.6.4.d	**	463 816
12A.6.68	12A.6.4.d	**	463 816
12A.6.69	12A.6.4.d	***	816 751 463
12A.6.70	12A.6.4.d	*	751 749
12A.6.71	12A.6.4.d	**	816 463
12A.6.72	12A.6.4.d	**	463 816
12A.6.73	12A.6.4.e	**	749 486 1015
12A.6.74	12A.6.4.e	*	749 486
12A.6.75	12A.6.4.e	***	749 750 105 104
12A.6.76	12A.6.4.e	**	749 750 701
12A.6.77	12A.6.4.e	**	749 750 701
12A.6.78	12A.6.4.e	***	104 105 749 701
12A.6.79	12A.6.4.e	**	486 750 749 701
12A.6.80	12A.6.4.f	***	1208 751 486 579
12A.6.81	12A.6.4.f	***	750 438
12A.6.82	12A.6.4.f	***	749 751 1208
12A.6.83	12A.6.4.f	**	1208 106 751 750
12A.6.84	12A.6.4.f	**	1208 750 701
12A.6.85	12A.6.4.f	**	749 750 701 1208
12A.6.86	12A.6.4.f		861 486
12A.6.87	12A.6.4.f	***	486 918
12A.6.88	12A.6.4.f		579
12A.6.89	12A.6.3.e.i	**	751 701
12A.6.90	12A.6.4.d	**	816 463
12A.6.91	12A.6.4.b	**	1041 401
12A.6.92	12A.6.4.a	*	869
12A.6.93	12A.6.2.b	*	751 749
12A.6.94	12A.6.3.e	*	749 995
12A.6.95	12A.6.3.c	**	104 105 757
12A.6.96	12A.6.1.	**	751 463
12A.6.97	12A.6.2.b	**	701 751 749 643
12A.6.98	12A.6.4.e	**	315 750 1015 759
12A.6.99	12A.6.4.c	*	1176 756 401 1041 749
12A.6.100	12A.6.3.b	**	701 749 816
12A.6.101	12A.6.	**	248 249 302
12A.6.102	12A.6.1.	**	751
12A.6.103	12A.6.2.b	**	749 751
12A.6.104	12A.6.1.	***	751 816

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.6.105	12A.6.1.	**	103 751 995
12A.6.106	12A.6.1.	***	751
12A.6.107	12A.6.2.b	*	749 751 816
12A.6.108	12A.6.2.b	*	696 701 751 995
12A.6.109	12A.6.2.b	*	751 816
12A.6.110	12A.6.3.a	***	557 757 1181
12A.6.111	12A.6.3.a	*	749
12A.6.112	12A.6.3.a	*	757 995
12A.6.113	12A.6.3.b	*	749 751
12A.6.114	12A.6.3.b	**	749 751
12A.6.115	12A.6.3.c	***	104
12A.6.116	12A.6.3.d	*	561 750 1015
12A.6.117	12A.6.3.d	***	750 1096
12A.6.118	12A.6.3.e	***	749 750 1015
12A.6.119	12A.6.3.e.i	*	749
12A.6.120	12A.6.3.e.i	*	749
12A.6.121	12A.6.3.e.ii	***	749 750 1015
12A.6.122	12A.6.3.e.ii	**	749 1015
12A.6.123	12A.6.3.e.ii	**	701 750 51 484 749
12A.6.124	12A.6.3.e.ii	***	315 484 749 1015
12A.6.125	12A.6.3.e.ii	***	749 750 1015
12A.6.126	12A.6.3.e.ii	***	749 750
12A.6.127	12A.6.3.e.ii	**	315 484 1015
12A.6.128	12A.6.4.a	**	866 867
12A.6.129	12A.6.4.a	*	866 867
12A.6.130	12A.6.4.a	**	866 867
12A.6.131	12A.6.4.a	**	866 867
12A.6.132	12A.6.4.a	*	866 867
12A.6.133	12A.6.4.a	*	866 867
12A.6.134	12A.6.4.a	**	866 867
12A.6.135	12A.6.4.a	**	552 749
12A.6.136	12A.6.4.a	***	552 866 867 1212
12A.6.137	12A.6.4.b	**	401 463 1041
12A.6.138	12A.6.4.b	**	401 438 1041
12A.6.139	12A.6.4.b	**	401 463 1041
12A.6.140	12A.6.4.c	***	463 756
12A.6.141	12A.6.4.c	*	401 749 1041
12A.6.142	12A.6.4.f	**	401 463 749 750 756
12A.6.143	12A.6.4.f	***	749 751
12A.6.144	12A.6.4.d	***	749 751 816
12A.6.145	12A.6.4.f	**	749 750 1015
12A.6.146	12A.6.4.f	**	749 750 751
12A.6.147	12A.6.3.e.i	***	816 751 701
12A.6.148	12A.6.4.b	**	1041 401
12A.6.149	12A.6.2.b	***	749 751 103
12A.6.150	12A.6.3.c	**	816 751 749
12A.6.151	12A.6.4.c	*	1041 401 1176 756 749
12A.6.152	12A.6.4.d	***	816 463
12A.6.153	12A.6.4.a	**	866 995 463
12A.6.154	12A.6.4.e	**	749 750 701
12A.6.155	12A.6.4.f	***	315 463 750
12A.6.156	12A.6.3.b	**	751 995 701
12A.6.157	12A.6.3.e.ii	***	749 750 701

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.6.157	12A.6.3.d	**	750 106
12A.6.158	12A.6.4.f	***	751 701 414 486 1212
12A.6.159	12A.6.4.b	**	869 995
12A.6.160	12A.6.2.a	**	704 605
12A.6.161	12A.6.3.e.i	**	749 1015 750
12A.6.162	12A.6.3.e	*	749 995
12A.6.163	12A.6.4.b	*	866 816 463
12A.6.164	12A.6.4.e	*	749 463 995
12A.6.165	12A.6.4.e	**	749 750 701
12A.6.166	12A.6.3.b	**	749 995 764
12A.6.167	12A.6.3.d	***	866 750 1208
12A.6.168	12A.6.3.d	**	866 750 1208
12A.6.169	12A.6.3.b	*	749 701 995
12A.6.170	12A.6.4.f	**	751 486
12A.6.171	12A.6.4.d	*	751 701
12A.6.172	12A.6.3.e.i	*	749 757
12A.6.173	12A.6.4.e	***	749 757 701 1015 1208
12A.6.174	12A.6.3.b	*	995 749 751
12A.6.175	12A.6.4.c	*	1041 401 756 1176
12A.6.176	12A.6.2.b	*	751 203
12A.6.177	12A.6.3.c	**	104 105 701
12A.6.178	12A.6.3.d	**	749 750 751
12A.6.179	12A.6.3.e	*	749 751
12A.6.180	12A.6.4.b		1041 401 866
12A.6.181	12A.6.4.a		749 643 701 866
12A.6.182	12A.6.1.	***	816 751
12A.6.183	12A.6.4.e	***	749 757 701 1015 1208
12A.6.184	12A.6.4.f	**	701 486 557
12A.6.185	12A.6.4.c	*	1041 401 756 1176 749
12A.6.186	12A.6.2.b	***	749 995 89 103
12A.6.187	12A.6.3.c	***	486 751 103
12A.6.188	12A.6.3.d	***	751 486 1015
12A.6.189	12A.6.4.b	**	1041 401 1176 756 749
12A.6.190	12A.6.1.	*	751 103
12A.6.191	12A.6.4.a	***	866 1239
12A.6.192	12A.6.3.b	*	751 995 701
12A.6.193	12A.6.4.d	**	463 816
12A.6.194	12A.6.3.e.i	**	995
12A.6.195	12A.6.4.g	*	172 701 751
12A.6.196	12A.6.4.a	*	869
12A.6.197	12A.6.1.	***	751 749 103 701
12A.6.198	12A.6.3.d	**	995 1015 701 751
12A.6.199	12A.6.3.d	**	816 751
12A.6.200	12A.6.3.d	**	103 486 750
12A.6.201	12A.6.4.b	*	401 1041 866
12A.6.202	12A.6.4.e	**	749 750 701
12A.6.203	12A.6.3.b	*	751 749 701 764
12A.6.204	12A.6.4.c	**	756 104 105
12A.6.205	12A.6.3.e.i	*	749 995
12A.6.206	12A.6.4.d	*	463 816

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.7.1	12A.7.3.c	**	240 696 463
12A.7.2	12A.7.1.	***	463
12A.7.3	12A.7.1.	*	1130 764 463 1212
12A.7.4	12A.7.1.a	***	463 613 201
12A.7.5	12A.7.1.a	**	1130
12A.7.6	12A.7.1.a	***	126
12A.7.7	12A.7.1.c	**	840 463 796
12A.7.8	12A.7.1.c	***	15 840 630
12A.7.9	12A.7.1.c	***	463 796 840 630
12A.7.10	12A.7.2.a	***	463 613 201
12A.7.11	12A.7.2.b	**	394
12A.7.12	12A.7.2.b	***	463 619
12A.7.13	12A.7.2.b	**	796 576
12A.7.14	12A.7.2.b	**	847 463 503
12A.7.15	12A.7.2.b	**	847 463
12A.7.16	12A.7.2.b	***	463 1192
12A.7.17	12A.7.2.c	***	796 576
12A.7.18	12A.7.2.c	***	796 576
12A.7.19	12A.7.2.c	***	15 840 630
12A.7.20	12A.7.2.c	*	463 796 764
12A.7.21	12A.7.2.c		463 796
12A.7.22	12A.7.2.c	**	796 463
12A.7.23	12A.7.2.c	**	463 796 840
12A.7.24	12A.7.2.c	***	463 847
12A.7.25	12A.7.2.c	**	796 576
12A.7.26	12A.7.2.c		463 796 605 201 200
12A.7.27	12A.7.2.d	*	94 463
12A.7.28	12A.7.3.		106 751
12A.7.29	12A.7.3.a	**	106 107
12A.7.30	12A.7.3.a	***	658 107
12A.7.31	12A.7.3.a	**	783
12A.7.32	12A.7.3.a	***	123 414 107 853
12A.7.33	12A.7.3.b	***	1256 240
12A.7.34	12A.7.3.b		369 106 751
12A.7.35	12A.7.3.b	***	369 751 376
12A.7.36	12A.7.3.b	***	107 240 701
12A.7.37	12A.7.3.b	***	107 701 751
12A.7.38	12A.7.3.c	**	750 979 983 722
12A.7.39	12A.7.3.c	**	240 106 751
12A.7.40	12A.7.3.c	***	658 429 240
12A.7.41	12A.7.3.c	***	106 751 750 1268 303
12A.7.42	12A.7.3.c		658
12A.7.43	12A.7.3.c	**	751 979 853
12A.7.44	12A.7.3.c	**	508 414 106 1208 488
12A.7.45	12A.7.3.c	***	488 1208
12A.7.46	12A.7.3.c	***	751 486 369
12A.7.47	12A.7.1.c	*	796 87 605 68
12A.7.48	12A.7.2.b	*	844 1192 576
12A.7.49	12A.7.3.b	***	751 106 915
12A.7.50	12A.7.1.c	**	463 796 917
12A.7.51	12A.7.2.c	**	463 793 796
12A.7.52	12A.7.2.a	***	1192 884 605

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.7.53	12A.7.2.c	**	463 840 796
12A.7.54	12A.7.1.a	**	796 578 776
12A.7.55	12A.7.1.c	**	796 249 87
12A.7.56	12A.7.1.c	**	776 11 840 796
12A.7.57	12A.7.2.c	***	796 463 630
12A.7.58	12A.7.3.a	*	107 1044 227
12A.7.59	12A.7.1.a	*	1130 796
12A.7.60	12A.7.1.	*	427
12A.7.61	12A.7.1.c	**	796 11 555 577
12A.7.62	12A.7.2.c	**	796
12A.7.63	12A.7.2.	*	463
12A.7.64	12A.7.3.b	**	369 1239
12A.7.65	12A.7.2.b	*	463 796
12A.7.66	12A.7.2.b	**	796 463
12A.7.67	12A.7.3.c	**	485 414
12A.7.68	12A.7.2.c	**	463 394 796
12A.7.69	12A.7.3.b	***	414 303
12A.7.70	12A.7.2.c	**	463 796
12A.7.71	12A.7.2.b	***	463 796 876
12A.7.72	12A.7.2.c	*	917 463 796 576 776
12A.7.73	12A.7.3.b	***	240 701 106
12A.7.74	12A.7.3.b	**	240 751 106
12A.7.75	12A.7.3.c	***	106 240 751 244
12A.7.76	12A.7.1.a	*	1130 395
12A.7.77	12A.7.2.c	***	463 201
12A.7.78	12A.7.3.a	*	1238 107 106
12A.7.79	12A.7.2.d	***	1192 841 463
12A.7.80	12A.7.2.c	***	796 463
12A.7.81	12A.7.3.c	***	663 429 240 436
12A.7.82	12A.7.2.c	*	463 796 552
12A.7.83	12A.7.2.b	***	463 796
12A.7.84	12A.7.3.c	**	106 751 992
12A.7.85	12A.7.3.c	**	106 751
12A.7.86	12A.7.1.	***	852 249
12A.7.87	12A.7.2.d	*	821 622
12A.7.88	12A.7.3.a	*	1238 787
12A.7.89	12A.7.1.a	*	1130
12A.7.90	12A.7.3.a		1238
12A.7.91	12A.7.3.b	**	106 1239 1208 508
12A.7.92	12A.7.3.c	*	240 486 751 1212 1256
12A.7.93	12A.7.2.c	**	796 463 840 776
12A.7.94	12A.7.2.c	*	796 463 552 776
12A.7.95	12A.7.3.a	*	107 1238 414 989
12A.7.96	12A.7.3.c	**	240 486 172 1207 1256
12A.7.97	12A.7.2.a	**	886 1192 463 219
12A.7.98	12A.7.1.a	*	578 126
12A.7.99	12A.7.3.b	*	414 751 106 1256
12A.7.100	12A.7.1.	*	796 917 577
12A.7.101	12A.7.3.c	*	106 1208 1239 1256 1212
12A.7.102	12A.7.3.c	*	751 106 1256
12A.7.103	12A.7.2.c	*	463 796 576 776
12A.7.104	12A.7.3.c	**	106 1208 486 750

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.7.105	12A.7.3.a	***	414 703 696
12A.7.106	12A.7.3.c	***	463 796 576 701
12A.7.107	12A.7.2.c	**	463 796
12A.7.108	12A.7.2.c	**	463 796
12A.7.109	12A.7.2.c	**	463 796
12A.7.110	12A.7.2.b	***	1192 463
12A.7.111	12A.7.1.a	*	1130 722
12A.7.112	12A.7.3.c	**	106 751
12A.7.113	12A.7.3.c	**	751 1208 106
12A.7.114	12A.7.2.d	**	94 463
12A.7.115	12A.7.2.b	**	126 463 164 886
12A.7.116	12A.7.3.c	**	106 749 751 701
12A.7.117	12A.7.3.c	**	106 701 240
12A.7.118	12A.7.3.c	***	106 701
12A.7.119	12A.7.2.c	***	463 795 576 847
12A.7.120	12A.7.3.c	**	106 701
12A.7.121	12A.7.3.b	**	106 751
12A.7.122	12A.7.2.a	***	1192 840
12A.7.123	12A.7.3.a	***	1238 107 227
12A.7.124	12A.7.3.c	**	749 751 438
12A.7.125	12A.7.3.c	***	749 751 438
12A.7.126	12A.7.3.b	***	749 463 701 796
12A.7.127	12A.7.3.c	**	414 701 751 796
12A.7.128	12A.7.2.c	***	463 847
12A.7.129	12A.7.2.c	**	463 796
12A.7.130	12A.7.3.a	*	106 1238
12A.7.131	12A.7.2.b	*	1192 463
12A.7.132	12A.7.3.a		414 107 1238
12A.7.133	12A.7.2.d	***	1130 89
12A.7.134	12A.7.3.b	**	106 750 751 463
12A.7.135	12A.7.3.c	***	106 750 1208
12A.7.136	12A.7.2.d	***	463 1192
12A.7.137	12A.7.2.d	***	463 1192 1193
12A.7.138	12A.7.1.c	*	463 796 576
12A.7.139	12A.7.2.c	**	796 463
12A.7.140	12A.7.2.c	**	749 463 796
12A.7.141	12A.7.3.c	***	106 1208 751 750
12A.7.142	12A.7.2.a	*	94 1192
12A.7.143	12A.7.3.	**	104 105 106
12A.7.144	12A.7.3.a		658 104 661 152
12A.7.145	12A.7.3.a	**	1238 107
12A.7.146	12A.7.2.d	***	463 176
12A.7.147	12A.7.3.	**	106 1208 1239
12A.7.148	12A.7.3.c	***	749 751 1015 1208
12A.7.149	12A.7.3.b		240 751
12A.7.150	12A.7.3.c	**	486 454 508
12A.7.151	12A.7.	***	463
12A.7.152	12A.7.3.c	***	488 751 995
12A.7.153	12A.7.1.a	*	463 847
12A.7.154	12A.7.1.a	*	395 1130
12A.7.155	12A.7.1.b	**	463 796
12A.7.156	12A.7.1.b	**	463 796

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.7.157	12A.7.1.b	**	463 796
12A.7.158	12A.7.1.b	***	463 796
12A.7.159	12A.7.1.b	**	483
12A.7.160	12A.7.1.b	**	463 796
12A.7.161	12A.7.1.b	**	463 796
12A.7.162	12A.7.1.b	**	21 75 76 796
12A.7.163	12A.7.1.b	***	463 796
12A.7.164	12A.7.1.b	**	463 796
12A.7.165	12A.7.2.b	**	463 847 1192
12A.7.166	12A.7.3.c	***	552 749
12A.7.167	12A.7.2.d	**	463 1192
12A.7.168	12A.7.2.d	*	463 514
12A.7.169	12A.7.2.d	**	249 947 1015
12A.7.170	12A.7.3.a	*	557 853 1212
12A.7.171	12A.7.3.b	***	240 749 750 751
12A.7.172	12A.7.3.a	**	106 107 227 414
12A.7.173	12A.7.3.a	**	107 414
12A.7.174	12A.7.3.c	***	240 749 750 751
12A.7.175	12A.7.3.a	**	301 749 751
12A.7.176	12A.7.3.c	**	488 749 750 751
12A.7.177	12A.7.3.a	*	749 750 751
12A.7.178	12A.7.3.a	*	106 107 414 787
12A.7.179	12A.7.3.a	*	106 107
12A.7.180	12A.7.3.a	***	302 749 750 751
12A.7.181	12A.7.3.a	*	107
12A.7.182	12A.7.3.c	**	495 508 750
12A.7.183	12A.7.3.b	*	557 853 1212
12A.7.184	12A.7.3.c	**	240 749 751
12A.7.185	12A.7.3.c	**	240 749 751
12A.7.186	12A.7.3.b	**	106 107
12A.7.187	12A.7.3.c	***	240 486 750 751
12A.7.188	12A.7.3.c	**	749 750 751 950
12A.7.189	12A.7.2.c	**	252 746 1208 1061
12A.7.190	12A.7.2		847

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.8.1	12A.8.1.b	*	1212 468
12A.8.2	12A.8.1.b	***	1125
12A.8.3	12A.8.1.c	*	308 1213
12A.8.4	12A.8.1.d	***	552
12A.8.5	12A.8.1.d	***	1212 315 715
12A.8.6	12A.8.1.e	***	463 552 438
12A.8.7	12A.8.1.e		357
12A.8.8	12A.8.1.e	**	552 249
12A.8.9	12A.8.1.e	**	567 318
12A.8.10	12A.8.1.e	**	357
12A.8.11	12A.8.1.f		309
12A.8.12	12A.8.2.	*	1126
12A.8.13	12A.8.2.	**	1061 1025 1054
12A.8.14	12A.8.2.	*	1025 879 1061
12A.8.15	12A.8.2.a	*	1059 1064
12A.8.16	12A.8.2.a	**	1061
12A.8.17	12A.8.2.b	*	1061 1025
12A.8.18	12A.8.2.b	*	751 749 252 1061
12A.8.19	12A.8.2.b		1061 1189
12A.8.20	12A.8.2.b	***	1054 802 1060
12A.8.21	12A.8.2.c	**	330 1208 252 1061
12A.8.22	12A.8.2.c	**	701 751 252 1061
12A.8.23	12A.8.2.c	**	1025 1189
12A.8.24	12A.8.2.c	**	1208 331 253
12A.8.25	12A.8.2.c	**	252 253
12A.8.26	12A.8.2.c	***	1025 701
12A.8.27	12A.8.2.c	*	330 253 1061
12A.8.28	12A.8.2.c	***	252 866 315 11
12A.8.29	12A.8.2.c	**	252 746
12A.8.30	12A.8.2.c	**	1057
12A.8.31	12A.8.2.c	**	252 746 1061
12A.8.32	12A.8.2.c	**	252 866 1061
12A.8.33	12A.8.2.c	***	1054 1025
12A.8.34	12A.8.2.c	***	252 746 701 1208 1061
12A.8.35	12A.8.2.c	**	252 746
12A.8.36	12A.8.2.c	**	252 1059 751
12A.8.37	12A.8.2.c	***	252 701
12A.8.38	12A.8.2.c	***	331 1208
12A.8.39	12A.8.2.c	***	252 746
12A.8.40	12A.8.2.c	**	252 701 751 749 1061
12A.8.41	12A.8.2.c	*	866 701 1061
12A.8.42	12A.8.2.c	**	252 749 701
12A.8.43	12A.8.2.c	**	1208 252 751 746
12A.8.44	12A.8.1.b	**	134 135 315 1140 1212
12A.8.45	12A.8.1.d	*	369 557 853 891 1212
12A.8.46	12A.8.1.e	**	309 357 1212
12A.8.47	12A.8.1.e	**	290 554 1212
12A.8.48	12A.8.1.e	***	357 552
12A.8.49	12A.8.1.f		304 569 1212
12A.8.50	12A.8.1.f	***	309 1061
12A.8.51	12A.8.2.a	***	540 680 1061
12A.8.52	12A.8.2.a	*	1059 1061 1064

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.8.53	12A.8.2.a	***	1025 1054
12A.8.54	12A.8.2.a	***	540 1061
12A.8.55	12A.8.2.b	*	172 1057
12A.8.56	12A.8.2.b	**	1025 1026 1059 1061
12A.8.57	12A.8.2.b	*	1025 1026 1061
12A.8.58	12A.8.2.b	***	484 1061
12A.8.59	12A.8.2.c	**	
12A.8.60	12A.8.2.c	**	252 701
12A.8.61	12A.8.2.c	**	866 867 1061
12A.8.62	12A.8.2.c	**	252 1059 1061 1064
12A.8.63	12A.8.2.c	***	637 1054 1212
12A.8.64	12A.8.2.c	**	252 1051 1061
12A.8.65	12A.8.2.c	***	252 749
12A.8.66	12A.8.2.c	***	252 1061 1208
12A.8.67	12A.8.2.c	***	11 253 331
12A.8.68	12A.8.2.c	***	1054
12A.8.69	12A.8.1.b	**	315 1212 559
12A.8.70	12A.8.1.e.iii	***	309
12A.8.71	12A.8.2.c	***	1054 567
12A.8.72	12A.8.2.c	***	1208 1061 746 701
12A.8.73	12A.8.2.	***	1025
12A.8.74	12A.8.2.	***	1061 544
12A.8.75	12A.8.1.e	*	1214 308
12A.8.76	12A.8.2.c	*	751 1208 746 1212
12A.8.77	12A.8.2.c	**	252 746 331
12A.8.78	12A.8.1.e	***	463 552 438
12A.8.79	12A.8.1.e	***	552 463 701
12A.8.80	12A.8.2.a	**	1061 345
12A.8.81	12A.8.1.f	***	309
12A.8.82	12A.8.2.c	*	1208 330
12A.8.83	12A.8.2.c	**	751 252 1061
12A.8.84	12A.8.2.c	**	751 1061 252
12A.8.85	12A.8.1.f	***	357 309
12A.8.86	12A.8.2.c	***	252 701 751 315
12A.8.87	12A.8.2.c	***	252 751 1208 684
12A.8.88	12A.8.1.e	**	1022 552 553 290
12A.8.89	12A.8.2.c	***	866 1061
12A.8.90	12A.8.2.c	**	751 749 252 1061
12A.8.91	12A.8.1.e	***	552 866 463 749
12A.8.92	12A.8.2.c	***	749 1061 252
12A.8.93	12A.8.2.a	**	1059 343 1061 1064
12A.8.94	12A.8.2.c	**	252 746 701 1208
12A.8.95	12A.8.2.c	**	252 701
12A.8.96	12A.8.1.e	***	552
12A.8.97	12A.8.1.f	***	309 164 567
12A.8.98	12A.8.2.c		1061 866
12A.8.99	12A.8.2.c		252 701 1208
12A.8.100	12A.8.1.e	***	552 463
12A.8.101	12A.8.2.c	***	252 701 1208 749
12A.8.102	12A.8.2.c	***	866 1059 1061 252
12A.8.103	12A.8.	*	345 498
12A.8.104	12A.8.	***	1025 415

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.8.105	12A.8.2.c	***	252 751 746
12A.8.106	12A.8.1.e	***	463 567
12A.8.107	12A.8.2.c	**	701 746 1061
12A.8.108	12A.8.1.e	***	357
12A.8.109	12A.8.2.c	**	1208 331 746
12A.8.110	12A.8.2.b	**	1057 484
12A.8.111	12A.8.2.c	*	252 746 701 1208
12A.8.112	12A.8.2.c	*	701 746 1061
12A.8.113	12A.8.2.c	**	1189 1061 330
12A.8.114	12A.8.2.c	***	1061 866 315 701
12A.8.115	12A.8.1.e	***	567 274 1120
12A.8.116	12A.8.2.c		252 751 749
12A.8.117	12A.8.2.c	**	252 751 1208
12A.8.118	12A.8.1.f	***	309
12A.8.119	12A.8.2.c	***	252 605 1061 463
12A.8.120	12A.8.2.c	***	701 1208 746
12A.8.121	12A.8.2.c	***	1208 746 751 1061
12A.8.122	12A.8.2.c	**	1061 1189
12A.8.123	12A.8.1.e.iii	***	357
12A.8.124	12A.8.2.c	**	1061 252 749 701
12A.8.125	12A.8.2.c	**	1054 701 864
12A.8.126	12A.8.2.b	*	1061 343
12A.8.127	12A.8.2.c	**	866 1061
12A.8.128	12A.8.2.c	***	252 746 751
12A.8.129	12A.8.1.f	***	309 1050
12A.8.130	12A.8.2.c	**	701 1208 253 746
12A.8.131	12A.8.2.	*	343 969
12A.8.132	12A.8.2.c	***	331 253
12A.8.133	12A.8.1.d	***	867 1119
12A.8.134	12A.8.1.e	***	552 866 438
12A.8.135	12A.8.2.c	**	1208 751 746

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.9.1	12A.9.4.b	***	414 979 1212
12A.9.2	12A.9.	***	1116 75 172 1061
12A.9.3	12A.9.1.a	**	617 722
12A.9.4	12A.9.1.b	**	370 800 806
12A.9.5	12A.9.1.b	**	370 800
12A.9.6	12A.9.1.b	**	370 800
12A.9.7	12A.9.1.c	**	11 341 633
12A.9.8	12A.9.1.c	***	605 620
12A.9.9	12A.9.1.c	**	463 605
12A.9.10	12A.9.2.a	***	70 369 843 988
12A.9.11	12A.9.2.b	**	429 557 843 853 988
12A.9.12	12A.9.2.b	**	988 992
12A.9.13	12A.9.2.c	***	184 192 369
12A.9.14	12A.9.2.c	***	843 988
12A.9.15	12A.9.2.c	**	387 515 850 980 992
12A.9.16	12A.9.2.c	***	844
12A.9.17	12A.9.4.b	**	16 785 856 1061
12A.9.18	12A.9.4.b	**	111 116 1061 1106
12A.9.19	12A.9.4.b	***	11 16 21 928
12A.9.20	12A.9.4.b	**	16 75 562 566
12A.9.21	12A.9.4.b	**	16 111 115
12A.9.22	12A.9.5.a	**	16 878 924 979 1022
12A.9.23	12A.9.5.a	***	11 16 156 585
12A.9.24	12A.9.5.a	**	16 767 1022 1212
12A.9.25	12A.9.5.a	**	16 787 915 1022
12A.9.26	12A.9.5.a	**	11 16 1022
12A.9.27	12A.9.5.a	***	11 16 156 585
12A.9.28	12A.9.5.d	**	414 787
12A.9.29	12A.9.6.d	***	11 21 274 988
12A.9.30	12A.9.6.d	***	26 722 843 988 990
12A.9.31	12A.9.6.a	***	106 915 979
12A.9.32	12A.9.5.a	***	783 16
12A.9.33	12A.9.1.c	**	605 620 754 106
12A.9.34	12A.9.1.c		611 605 147 438 754
12A.9.35	12A.9.6.b	***	106 557 485
12A.9.36	12A.9.5.a	***	1022 796 787 16 776
12A.9.37	12A.9.4.	***	746 568 252 858
12A.9.38	12A.9.3.	***	783 619
12A.9.39	12A.9.3.c	***	240 106 701 751
12A.9.40	12A.9.3.c	***	429 751 749 244

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.10.1	12A.10.1.e	**	164 463 979 1212
12A.10.2	12A.10.1.h.iii		143
12A.11.1	12A.11.3.b	***	388 515
12A.12.1	12A.12.	***	445 38
12A.12.2	12A.12.	***	
12A.12.3	12A.12.	***	260 722
12A.12.4	12A.12.a	*	801
12A.12.5	12A.12.a		722 853 147
12A.12.6	12A.12.a	***	722 478 873
12A.12.7	12A.12.a		722 680 928
12A.12.8	12A.12.a	**	94 873
12A.12.9	12A.12.a	**	
12A.12.10	12A.12.a	**	621 874 445
12A.12.11	12A.12.a	**	387
12A.12.12	12A.12.a	**	
12A.12.13	12A.12.a	***	873 94
12A.12.14	12A.12.a	**	445 1195
12A.12.15	12A.12.a	**	829 376 213
12A.12.16	12A.12.a	***	873 388
12A.12.17	12A.12.b	***	801 986 388
12A.12.18	12A.12.b	*	873 388 841
12A.12.19	12A.12.b	*	794 841
12A.12.20	12A.12.b	***	621 873
12A.12.21	12A.12.b	*	794 388
12A.12.22	12A.12.b	**	794
12A.12.23	12A.12.b	**	873 503
12A.12.24	12A.12.b	***	38 847
12A.12.25	12A.12.b		621 873 1193
12A.12.26	12A.12.b	**	503 794
12A.12.27	12A.12.b		515
12A.12.28	12A.12.b	**	1232 873 445
12A.12.29	12A.12.a	**	873 874
12A.12.30	12A.12.e	**	873 445
12A.12.31	12A.12.e	**	873 874 724
12A.12.32	12A.12.c	**	873 97
12A.12.33	12A.12.e	***	95 874 616
12A.12.34	12A.12.a	**	874 873
12A.12.35	12A.12.	**	873
12A.12.36	12A.12.	**	873 445
12A.12.37	12A.12.	**	873 874
12A.12.38	12A.12.	***	445 873 874 621
12A.12.39	12A.12.	*	873 874
12A.12.40	12A.12.	*	396 588
12A.12.41	12A.12.a	***	621
12A.12.42	12A.12.b	*	445 503 872 873
12A.12.43	12A.12.a	**	94 873
12A.12.44	12A.12.a	**	26 986
12A.12.45	12A.12.a	*	94 873
12A.12.46	12A.12.a	**	378 873
12A.12.47	12A.12.b	**	213 384 841 873 1195

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.12.48	12A.12.b	*	874 1193
12A.12.49	12A.12.b	*	515
12A.12.50	12A.12.e	***	387
12A.12.51	12A.12.d	***	94 874 873 213
12A.12.52	12A.12.e	***	459 378
12A.12.53	12A.12.e	***	95 873
12A.12.54	12A.12.a	*	395 873
12A.12.55	12A.12.c	***	829 873 1114
12A.12.56	12A.12.e	***	722 872 873
12A.12.57	12A.12.b	*	97 873 874
12A.12.58	12A.12.b	***	28
12A.12.59	12A.12.b	***	38 986
12A.12.60	12A.12.d	***	621 445 503 873
12A.12.61	12A.12.a	**	392
12A.12.62	12A.12.a	**	873 222
12A.12.63	12A.12.a	**	1193 841
12A.12.64	12A.12.d	*	616
12A.12.65	12A.12.b	**	621 388
12A.12.66	12A.12.b	***	394
12A.12.67	12A.12.d	**	95
12A.12.68	12A.12.e	*	611 873 872
12A.12.69	12A.12.	***	613 611
12A.12.70	12A.12.a	*	722 873
12A.12.71	12A.12.b	*	445 503 621 94
12A.12.72	12A.12.c		872 147 873
12A.12.73	12A.12.c	***	501 388 873
12A.12.74	12A.12.d	***	621 873
12A.12.75	12A.12.d		503 621 96
12A.12.76	12A.12.d	***	94 515 25
12A.12.77	12A.12.d	***	722 873 986
12A.12.78	12A.12.d	**	621 95 515
12A.12.79	12A.12.d	**	621 874 445
12A.12.80	12A.12.d	**	841 213
12A.12.81	12A.12.d	**	96 873
12A.12.82	12A.12.d	**	95
12A.12.83	12A.12.d	**	95
12A.12.84	12A.12.d	***	722 873
12A.12.85	12A.12.d	*	95
12A.12.86	12A.12.d	***	392
12A.12.87	12A.12.d	**	95 873
12A.12.88	12A.12.d	**	873 874
12A.12.89	12A.12.d	**	95
12A.12.90	12A.12.d	***	722 1193
12A.12.91	12A.12.d	***	873 621 503
12A.12.92	12A.12.d	***	722 873
12A.12.93	12A.12.d	***	722
12A.12.94	12A.12.d	**	622 986
12A.12.95	12A.12.e	***	387 94 874
12A.12.96	12A.12.e	***	387
12A.12.97	12A.12.e	***	872 621
12A.12.98	12A.12.e	***	95 806
12A.12.99	12A.12.e	***	95

ID #	GUIDELINE	DIFFICULTY	KEYWORDS
12A.12.100	12A.12.e	*	722 986 388
12A.12.101	12A.12.e	***	95 872
12A.12.102	12A.12.e	***	378 387 388
12A.12.103	12A.12.e		387 388
12A.12.104	12A.12.e	**	387
12A.12.105	12A.12.e	**	874 873 872 910
12A.12.106	12A.12.e	***	621 874
12A.12.107	12A.12.e	**	95 873 874
12A.12.108	12A.12.e	**	387
12A.12.109	12A.12.e	**	387
12A.12.110	12A.12.e	***	621 873
12A.12.111	12A.12.e	***	387
12A.12.112	12A.12.e	***	621 1193
12A.12.113	12A.12.e	**	387
12A.12.114	12A.12.e	***	388 95
12A.12.115	12A.12.e	***	621
12A.12.116	12A.12.e	***	722 392
12A.12.117	12A.12.e	***	388 622
12A.12.118	12A.12.e	***	621 873
12A.12.119	12A.12.e	***	621
12A.12.120	12A.12.d	**	95 388 1250

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540. Instrument Pool :  
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